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(54) Title: SUBSTITUTED OXOAZAHETEROCYCLYL COMPOUNDS

(57) Abstract: This invention is directed to oxoazaheterocyclyl compounds which inhibit Factor Xa, to oxoazaheterocyclyl com-
pounds which inhibit both Factor Xa and Factor IIa, to pharmaceutical compositions comprising these compounds, to intermediates
useful for preparing these compounds, to a method of directly inhibiting Factor Xa and to a method of simultaneously directly in-
hibiting Factor Xa and Factor IIa.

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Description

SUBSTITUTED OXOAZAHETEROCYCLYL COMPOUNDS

5 FIELD OF THE INVENTION

This invention is directed to oxoazaheterocyclyl compounds which inhibit Factor

This invention is directed to oxoazaheterocyclyl compounds which inhibit Factor Xa, to pharmaceutical compositions comprising these compounds, to intermediates useful for preparing these compounds and to a method of inhibiting Factor Xa. This invention is also

- 10 directed to oxoazaheterocyclyl compounds which directly inhibit both Factor Xa and Factor IIa (thrombin), to pharmaceutical compositions comprising these compounds, to intermediates useful for preparing these compounds and to a method of simultaneously directly inhibiting both Factor Xa and Factor IIa (thrombin).

BACKGROUND OF THE INVENTION

- 15 Factor Xa and Factor Xa assembled in the prothrombinase complex (Factor Xa, Factor Va, calcium and phospholipid) activate prothrombin (Factor II) to generate thrombin (Factor IIa). Factor Xa is strategically located at the intersection of extrinsic and intrinsic pathways of the blood coagulation system. Thus, an inhibitor of Factor Xa inhibits the formation of thrombin and, therefore, is useful for preventing or treating disorders related to blood coagulation in
- 20 mammals.

- Anticoagulant therapy is indicated for the treatment and prophylaxis of a variety of thrombotic conditions of both the venous and arterial vasculature. In the arterial system, abnormal thrombus formation is primarily associated with arteries of the coronary, cerebral and peripheral vasculature. The diseases associated with thrombotic occlusion of these vessels
- 25 principally include acute myocardial infarction (AMI), unstable angina, thromboembolism, acute vessel closure associated with thrombolytic therapy and percutaneous transluminal coronary angioplasty (PTCA), transient ischemic attacks, stroke, intermittent claudication and bypass grafting (CABG) of the coronary or peripheral arteries. Chronic anticoagulant therapy may also be beneficial in preventing the vessel luminal narrowing (restenosis) that often occurs following
- 30 PTCA and CABG, and in the maintenance of vascular access patency in long-term hemodialysis patients. With respect to the venous vasculature, pathologic thrombus formation frequently occurs in the veins of the lower extremities following abdominal, knee and hip surgery (deep vein thrombosis, DVT). DVT further predisposes the patient to a higher risk of pulmonary thromboembolism. A systemic, disseminated intravascular coagulopathy (DIC)
- 35 commonly occurs in both vascular systems during septic shock, certain viral infections and

cancer. This condition is characterized by a rapid consumption of coagulation factors and their plasma inhibitors resulting in the formation of life-threatening clots throughout the microvasculature of several organ systems.

In addition to their use in anticoagulant therapy, Factor Xa inhibitors are useful in the treatment or prevention of other diseases in which the generation of thrombin has been implicated as playing a physiologic role. For example, thrombin has been proposed to contribute to the morbidity and mortality of such chronic and degenerative diseases as arthritis, cancer, atherosclerosis and Alzheimer's disease by virtue of its ability to regulate many different cell types through specific cleavage and activation of a cell surface thrombin receptor, mitogenic effects, diverse cellular functions such as cell proliferation, for example, abnormal proliferation of vascular cells resulting in restenosis or angiogenesis, release of PDGF and DNA syntheses. Inhibition of Factor Xa will effectively block thrombin generation and therefore neutralize any physiologic effects of thrombin on various cell types.

The representative indications discussed above include some, but not all, of the possible clinical situations amenable to treatment with a Factor Xa inhibitor.

Oxoazaheterocyclyl Factor Xa inhibitors are disclosed in International Patent Application Numbers PCT/US98/07158, published Oct. 22, 1998; PCT/US98/07159, published Oct. 22, 1998; PCT/US98/07160, published Oct. 22, 1998; PCT/US98/07161, published Oct. 22, 1998; and PCT/US96/09290, published Dec. 19, 1996. Oxoazaheterocyclyl fibrinogen antagonists are disclosed in International Patent Application Number PCT/US92/09467, published May 13, 1993.

Vascular injury, caused by biochemical or physical perturbations, results in the activation of the coagulation system, culminating in the generation of thrombin. Thrombin promotes thrombus formation by catalyzing the transformation of fibrinogen to fibrin, by activating Coagulation Factor XIII, which stabilizes the thrombus, and by activating platelets. Thrombin promotes further thrombus growth by positive feedback to the coagulation cascade (activation of Coagulation Factors V and VIII), resulting in the explosive production of thrombin. Thrombin is present, and active, in the thrombi of patients with thrombotic vascular disease. Thrombin inhibition prevents the action of thrombin after thrombin has been activated from prothrombin. An inhibitor of thrombin inhibits cleavage of fibrinogen to fibrin, activation of Factor XIIIa, activation of platelets, and feedback of thrombin to the coagulation cascade to generate more thrombin. Consequently, inhibition of thrombin activity with a direct thrombin inhibitor would be useful for preventing or treating disorders related to blood coagulation in mammals.

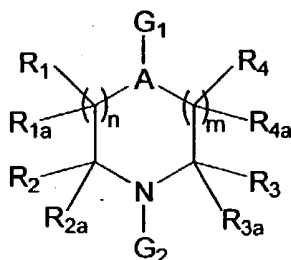
The combined inhibitors of Factor Xa and Factor IIa described herein inhibit thrombin activity (via IIa inhibition) and thrombin production (via Factor Xa inhibition). Therefore, these

agents inhibit any thrombin that may be present and also inhibit the further production of thrombin. Other agents which have this dual activity include heparin and low molecular weight heparins (LMWHs), which have demonstrated efficacy in thrombotic diseases. However, heparin and LMWHs act indirectly through a cofactor, antithrombin-III (ATIII), to inhibit Xa and

5 IIa. The heparin/ATIII complex is too large, however, to inhibit thrombus-bound Xa and IIa, thus limiting its efficacy. Direct inhibitors of Factor Xa and Factor IIa, as described herein, are capable of inhibiting soluble and thrombus-bound Xa and IIa, thus providing an important therapeutic advantage over currently available Xa/IIa inhibitors.

10 SUMMARY OF THE INVENTION

This invention is directed to a compound of formula I



or a pharmaceutically acceptable salt thereof, pharmaceutically acceptable prodrug thereof, an N-oxide thereof, a hydrate thereof or a solvate thereof

15 wherein

G_1 and G_2 are L_1 -Cy₁ or L_2 -Cy₂, provided that when R_1 and R_{1a} or R_4 and R_{4a} taken together form O or S, then G_1 is L_2 -Cy₂ and G_2 is L_1 -Cy₁, or when R_2 and R_{2a} or R_3 and R_{3a} taken together form O or S, then G_1 is L_1 -Cy₁ and G_2 is L_2 -Cy₂;

Cy₁ and Cy₂ are independently selected from optionally substituted aryl, optionally substituted

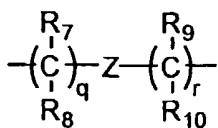
20 heteroaryl, optionally substituted cycloalkyl, optionally substituted cycloalkenyl, optionally substituted heterocyclyl, optionally substituted heterocyclenyl, optionally substituted fused arylcycloalkyl, optionally substituted fused arylcycloalkenyl, optionally substituted fused arylheterocyclyl, optionally substituted fused arylheterocyclenyl, optionally substituted fused heteroaryl-cycloalkyl, optionally substituted fused heteroaryl-cycloalkenyl, optionally substituted

25 fused heteroaryl-heterocyclyl and optionally substituted fused heteroaryl-heterocyclenyl;

L_1 is absent, O, NR_5 , $-S(O)p-$, $-S(O)pNR_5-$, $-C(X)Y-$ or $-L_3-Q-L_4-Q'-L_5-$, $-C(O)Y-C(X)Y-$, $-C(X)YC(O)-$,

$-C(O)NR_5-S(O)p-$, or $-C(O)C(O)NR_5S(O)p-$;

L_2 is absent or a group of formula



L₃ and L₅ are independently absent, optionally substituted alkylene, optionally substituted alkenylene or optionally substituted alkynylene;

L₄ is optionally substituted alkylene, optionally substituted alkenylene, or optionally substituted alkynylene;

Q and Q' are independently absent, O, S, NR₅, -S(O)p-, -S(O)pNR₅- or -C(X)Y-;

A is CH or N;

R₁, R_{1a}, R₂, R_{2a}, R₃, R_{3a}, R₄ and R_{4a} are independently selected from hydrogen, carboxy, alkoxy, carbonyl, Y₁Y₂NC(O)-, optionally substituted alkyl, optionally substituted aryl, optionally

substituted aralkyl, optionally substituted heteroaryl and optionally substituted heteroaralkyl, or R₁ and R_{1a}, R₂ and R_{2a}, R₃ and R_{3a}, or R₄ and R_{4a} taken together form O or S; or R₁ and R₂ together with the carbon atoms through which R₁ and R₂ are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group, or heterocyclenyl group; or R₃ and R₄ together with the carbon atoms through which R₃ and R₄ are linked form a cycloalkyl group, cycloalkenyl group,

heterocyclyl group, or heterocyclenyl group; or R_{1a} and R_{2a} are absent and R₁ and R₂ together with the carbon atoms through which R₁ and R₂ are linked form an aryl or heteroaryl group; or R_{3a} and R_{4a} are absent and R₃ and R₄ together with the carbon atoms through which R₃ and R₄ are linked form an aryl or heteroaryl group; or one or more of the pairs R₁ and R_{1a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl

or cycloalkenyl group; or R₂ and R_{2a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; or R₃ and R_{3a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; or R₄ and R_{4a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group;

m and n are independently 0, 1 or 2, provided that m and n are not both 0 and further provided that when R₁ and R_{1a} taken together form O or S, n is 1, and when R₄ and R_{4a} taken together form O or S, m is 1;

R₅ is hydrogen, optionally substituted alkyl, optionally substituted aralkyl, optionally substituted heteroaralkyl, R₆O(CH₂)_v-, R₆O₂C(CH₂)_x-, Y₁Y₂NC(O)(CH₂)_x-, or Y₁Y₂N(CH₂)_v-;

R₆ is hydrogen, optionally substituted alkyl, optionally substituted aralkyl or optionally substituted heteroaralkyl;

Y₁ and Y₂ are independently hydrogen, optionally substituted alkyl, optionally substituted alkoxy, optionally substituted aryloxy, optionally substituted aryl, optionally substituted aralkyl or

optionally substituted heteroaralkyl, or Y₁ and Y₂ taken together with the N through which Y₁ and Y₂ are linked form a monocyclic heterocyclyl;

R₇, R₈, R₉ and R₁₀ are independently selected from hydrogen, hydroxy, alkoxy, optionally substituted alkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally

substituted aralkyl and optionally substituted heteroaralkyl, provided that only one of R₇ and R₈ or one of R₉ and R₁₀ is hydroxy or alkoxy, and further provided when any of R₇, R₈, R₉ and R₁₀ is hydroxy or alkoxy, then the hydroxy or alkoxy is not α -substituted to an N, O or S in Z;

X is O or S;

Y is absent or is selected from O, S and NR₅;

Z is absent or is selected from optionally substituted lower alkenylene, optionally substituted lower alkynylene, O, -C(O)-, S(O)p, NR₅, -NR₅C(O)- and -C(O)NR₅;

x is 1, 2, 3 or 4;

v is 2, 3 or 4;

p is 1 or 2; and

q and r are independently 0, 1, 2 or 3, provided that q and r are not both 0,

and provided that when L₁ is O, NR₅, -S(O)p-, -S(O)pNR₅-, -C(X)Y- or -L₃-Q-L₄-Q'-L₅- and R₃ and R_{3a} taken together form O or S, then R₂ and R_{2a} are independently selected from hydrogen, alkyl, aminoalkyl, alkylaminoalkyl, alkoxy, alkoxyalkyl, alkoxyaminoalkyl, cycloalkylalkylamino, benzyloxyalkyl, isopropyl, aminomethyl, methoxyethylaminomethyl, piperazin, pyrrolidin,

ethoxymethyl, benzyloxymethyl, methoxymethyl, isobutyl, isopropylamino or isopropylaminomethyl, provided that R₂ and R_{2a} are not each hydrogen;

or when L₁ is O, NR₅, -S(O)p-, -S(O)pNR₅-, -C(X)Y- or -L₃-Q-L₄-Q'-L₅- and R₃ and R_{3a} taken together form O or S, then R₄ and R_{4a} taken together form O or S;

or when L₁ is O, NR₅, -S(O)p-, -S(O)pNR₅-, -C(X)Y- or -L₃-Q-L₄-Q'-L₅- and R₃ and R_{3a} taken together form O or S, then Cy₁ is thiophen-isoxazol, thiophen-pyrazol, thiophen-oxadiazol, thiophen-thiadiazol, thiophen-triazol, thiophen-pyridin or phenyl-triazol and Cy₂ is amino-quinazolin or pyrrolo-pyridin;

or when L₁ is O, NR₅, -S(O)p-, -S(O)pNR₅-, -C(X)Y- or -L₃-Q-L₄-Q'-L₅- then R₁ and R₂ together with the carbon atoms through which R₁ and R₂ are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group, or heterocyclenyl group; or R₃ and R₄ together with the carbon atoms through which R₃ and R₄ are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group, or heterocyclenyl group; or R_{1a} and R_{2a} are absent and R₁ and R₂ together with the carbon atoms through which R₁ and R₂ are linked form an aryl or heteroaryl group; or R_{3a} and R_{4a} are absent and R₃ and R₄ together with the carbon atoms through which R₃ and R₄ are

linked form an aryl or heteroaryl group; or one or more of the pairs R₁ and R_{1a} taken together

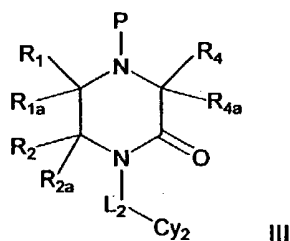
with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; or R_2 and R_{2a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; or R_3 and R_{3a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; or R_4 and R_{4a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group;

or when L_1 is O, NR_5 , $-S(O)p-$, $-S(O)pNR_5-$, $-C(X)Y-$ or $-L_3-Q-L_4-Q'-L_5-$, then R_1 , R_{1a} , R_2 , R_{2a} , R_3 , R_{3a} , R_4 and R_{4a} are independently $Y_1Y_2NC(O)-$ and Y_1 and Y_2 are independently hydrogen, optionally substituted alkoxy or optionally substituted aryloxy, but Y_1 and Y_2 are not simultaneously hydrogen, or when L_1 is O, NR_5 , $-S(O)p-$, $-S(O)pNR_5-$, $-C(X)Y-$ or $-L_3-Q-L_4-Q'-L_5-$, then Z is $-C(O)$.

In another aspect, this invention is directed to a pharmaceutical composition comprising a therapeutically effective amount of the compound of formula I or formula II and a pharmaceutically acceptable carrier.

In another aspect, this invention is directed to a method of treating a physiological disorder capable of being modulated by inhibiting Factor Xa comprising administering to a patient in need of such treatment a therapeutically effective amount of a compound of formula I or formula II.

In another aspect, this invention is directed to a compound of formula III

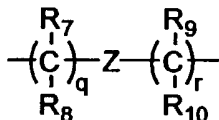


wherein P is H or a nitrogen protecting group;

R_1 , R_{1a} , R_2 , R_{2a} , R_4 and R_{4a} are independently selected from hydrogen, carboxy, alkoxycarbonyl, $Y_1Y_2NC(O)-$, optionally substituted alkyl, optionally substituted aryl, optionally substituted aralkyl, optionally substituted heteroaryl and optionally substituted heteroaralkyl, or R_1 and R_{1a} , R_2 and R_{2a} or R_4 and R_{4a} taken together form O or S; or R_1 and R_2 together with the carbon atoms through which R_1 and R_2 are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group, or heterocyclenyl group; or R_{1a} and R_{2a} are absent and R_1 and R_2 together with the carbon atoms through which R_1 and R_2 are linked form an aryl or heteroaryl group; or R_1 and R_{1a} taken together with the carbon atom through which they are linked form a 3 to 7

membered cycloalkyl or cycloalkenyl group; or R_2 and R_{2a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; or R_4 and R_{4a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group;

- 5 L_2 is absent or a group of formula



Cy_2 is selected from optionally substituted aryl, optionally substituted heteroaryl, optionally substituted cycloalkyl, optionally substituted cycloalkenyl, optionally substituted heterocyclyl, optionally substituted heterocyclenyl, optionally substituted fused arylcycloalkyl, optionally substituted fused arylcycloalkenyl, optionally substituted fused arylheterocyclyl, optionally substituted fused arylheterocyclenyl, optionally substituted fused heteroaryl cycloalkyl, optionally substituted fused heteroaryl cycloalkenyl, optionally substituted fused heteroaryl heterocyclyl and optionally substituted fused heteroaryl heterocyclenyl;

- 10 R_5 is hydrogen, optionally substituted alkyl, optionally substituted aralkyl, optionally substituted heteroaralkyl, $R_6O(CH_2)_v-$, $R_6O_2C(CH_2)_x-$, $Y_1Y_2NC(O)(CH_2)_x-$, or $Y_1Y_2N(CH_2)_v-$;

R_6 is hydrogen, optionally substituted alkyl, optionally substituted aralkyl or optionally substituted heteroaralkyl;

Y_1 and Y_2 are independently hydrogen, optionally substituted alkyl, optionally substituted alkoxy, optionally substituted aryloxy, optionally substituted aryl, optionally substituted aralkyl or optionally substituted heteroaralkyl, or Y_1 and Y_2 taken together with the N through which Y_1 and Y_2 are linked form a monocyclic heterocyclyl;

- 20 R_7 , R_8 , R_9 and R_{10} are independently selected from hydrogen, hydroxy, alkoxy, optionally substituted alkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted aralkyl and optionally substituted heteroaralkyl, provided that only one of R_7 and R_8 or one of R_9 and R_{10} is hydroxy or alkoxy, and further provided when R_7 , R_8 , R_9 and R_{10} is hydroxy or alkoxy, then the hydroxy or alkoxy is not α -substituted to a N, O or S in Z;

Z is absent or is selected from optionally substituted lower alkenylene, optionally substituted lower alkynylene, O, S(O)_p, -C(O)-, NR_5 , $-NR_5C(O)-$ and $-C(O)NR_5-$;

x is 1, 2, 3 or 4;

- 30 v is 2, 3 or 4; and

q and r are independently 0, 1, 2 or 3, provided that q and r are not both 0,

which is an intermediate useful in the preparation of the compound of formula I or formula II

DETAILED DESCRIPTION OF THE INVENTION

Definitions

As used above, and throughout the description of the invention, the following terms, unless otherwise indicated, shall be understood to have the following meanings:

5 "Derivative" means a chemically modified compound wherein the modification is considered routine by the ordinary skilled chemist, such as an ester or an amide of an acid, protecting groups, such as a benzyl group for an alcohol or thiol, and tert-butoxycarbonyl group for an amine.

"Patient" includes both human and other mammals.

10 "Alkyl" means an aliphatic hydrocarbon group, which may be straight or branched chain, having about 1 to about 20 carbon atoms in the chain. Preferred alkyl groups have 1 to about 12 carbon atoms in the chain. Branched means that one or more lower alkyl groups such as methyl, ethyl or propyl are attached to a linear alkyl chain. "Lower alkyl" means about 1 to about 4 carbon atoms in the chain which may be straight or branched. The alkyl may be
15 substituted with one or more "alkyl group substituents" which may be the same or different, and include halo, cycloalkyl, cycloalkenyl, heterocyclyl, heterocyclenyl, hydroxy, oxime, alkylthio, alkylsulfinyl, alkylsulfonyl, arylthio, arylsulfinyl, arylsulfonyl, heteroarylthio, heteroarylsulfinyl, heteroarylsulfonyl, isourea, guanidino, acylhydrazino, alkoxy, amino, carbamoyl, acylamino, aroylamino, carboxy, alkoxycarbonyl, aralkyloxycarbonyl and heteroaralkyloxycarbonyl.

20 Representative alkyl groups include methyl, trifluoromethyl, cyclopropylmethyl, cyclopentylmethyl, ethyl, n-propyl, i-propyl, n-butyl, t-butyl, n-pentyl, 3-pentyl, methoxyethyl, carboxymethyl, methoxycarbonylethyl, benzyloxycarbonylmethyl, and pyridylmethyloxycarbonylmethyl.

"Alkenyl" means a straight or branched aliphatic hydrocarbon group containing a
25 carbon-carbon double bond and having about 2 to about 15 carbon atoms in the chain. Preferred alkenyl groups have 2 to about 6 carbon atoms in the chain. Branched means that one or more lower alkyl groups such as methyl, ethyl or propyl are attached to a linear alkenyl chain. "Lower alkenyl" means about 2 to about 4 carbon atoms in the chain which may be straight or branched. The alkenyl group may be substituted by one or more alkyl group
30 substituents as defined herein. Representative alkenyl groups include ethenyl, propenyl, n-butenyl, i-butenyl, 3-methylbut-2-enyl, n-pentenyl, heptenyl, octenyl, decenyl, and the like.

"Alkylene" means a straight or branched bivalent hydrocarbon chain having from 1 to about 20 carbon atoms. The preferred alkylene groups are the lower alkylene groups having from 1 to about 6 carbon atoms. Alkylene may be substituted with 1 or more alkyl group

substituents as defined herein. Representative alkylene groups include methylene, ethylene, and the like.

"Alkenylene" means a bivalent group derived from a straight or branched chain hydrocarbon containing at least one carbon-carbon triple bond. The preferred alkenylene groups are the lower alkenylene groups having from 1 to about 6 carbon atoms. Alkenylene group may be substituted by one or more alkyl group substituents as defined herein. Representative alkenylene groups include $-\text{CH}=\text{CH}-$, $-\text{CH}_2\text{CH}=\text{CH}-$, $-\text{C}(\text{CH}_3)=\text{CH}-$, $-\text{CH}_2\text{CH}=\text{CHCH}_2-$, and the like.

"Alkynylene" means a bivalent group derived from a straight or branched chain hydrocarbon containing at least one carbon-carbon double bond. Preferred alkynylene groups are the lower alkynylene groups having from 1 to about 6 carbon atoms. Alkynylene may be substituted by one or more alkyl group substituents as defined herein. Representative alkynylene include $-\text{CH}::\text{CH}-$, $-\text{CH}::\text{CH}-\text{CH}_2-$, $-\text{CH}::\text{CH}-\text{CH}(\text{CH}_3)-$, and the like.

"Aralkylamino" means a (arylalkyl)(Y₂)N- group wherein the arylalkyl portion and Y₂ are as herein defined.

"Heteroaralkylamino" means a (heteroaralkyl)(Y₂)N- group wherein the heteroaralkyl portion and Y₂ are as defined herein.

"Heterocyclylalkyl" means a heterocyclyl-alkylene- group wherein the heterocyclyl portion and alkylene portion are as defined herein.

"Heterocyclylalkylamino" means a (heterocyclylalkyl)(Y₂)N- group wherein the heterocyclylalkyl portion and Y₂ are as defined herein.

"Heterocyclenylalkyl" means a heterocyclenyl-alkylene- group wherein the heterocyclenyl portion and alkylene portion are as defined herein.

"Heterocyclenylalkylamino" means a (heterocyclenylalkyl)(Y₂)N- group wherein the heterocyclenylalkyl portion and Y₂ are as defined herein.

"Alkoxyalkyl" means an alkoxy-alkylene- group wherein the alkoxy portion and alkylene portion are as defined herein.

"Alkylthioalkyl" means an alkylthio-alkylene- group wherein the alkylthio portion and alkylene portion are as defined herein.

"Alkylsulfinylalkyl" means an alkylsulfinyl-alkylene- group wherein the alkylsulfinyl portion and alkylene portion are as defined herein.

"Alkylsulfonylalkyl" means an alkylsulfonyl-alkylene- group wherein the alkylsulfonyl portion and alkylene portion are as defined herein.

"Acylalkyl" means an acyl-alkylene- group wherein the acyl portion and alkylene portion are as defined herein.

"Acylaminoalkyl" means an acyl-NH-alkylene- group wherein the acyl portion and alkylene portion are as defined herein.

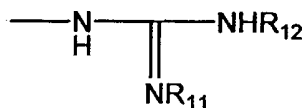
5 "Carbamoylalkyl" means an carbamoyl-alkylene- group wherein the carbamoyl portion and alkylene portion are as defined herein.

"Heterocyclalkyloxycarbonyl" means a heterocyclalkyl-O-C(O)- group wherein the heterocyclalkyl portion is as defined herein.

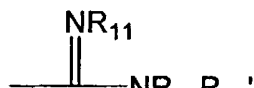


10 "Isourea" means a group of formula $\begin{array}{c} \text{---N---} \\ | \\ \text{H} \end{array} \begin{array}{c} \text{---} \\ || \\ \text{NR}_{11} \end{array} \text{---OR}_{11a}$ wherein R_{11} is as defined herein and R_{11a} is hydrogen, optionally substituted lower alkyl, optionally substituted aryl, or optionally substituted heteroaryl.

"Acylhydrazino" means a group of formula $Y_1Y_2N\text{---NHC(O)}\text{---}$, wherein Y_1 and Y_2 are as defined herein.



15 "Guanidino" or "guanidine" means a group of formula $\begin{array}{c} \text{---N---} \\ | \\ \text{H} \end{array} \begin{array}{c} \text{---} \\ || \\ \text{NR}_{11} \end{array} \text{---NHR}_{12}$ wherein R_{11} and R_{12} are as defined herein.



20 "Amidino" or "amidine" means a group of formula $\begin{array}{c} \text{NR}_{11} \\ || \\ \text{---} \end{array} \text{---NR}_{12}R_{12}'$ wherein R_{11} is selected from hydrogen, $R_6O_2C\text{---}$, $R_6O\text{---}$, $R_6C(O)\text{---}$, cyano, optionally substituted lower alkyl, nitro or $Y_1Y_2N\text{---}$ and R_{12} and R_{12}' are independently selected from hydrogen, optionally substituted lower alkyl, optionally substituted aralkyl and optionally substituted heteroaralkyl. Preferred amidino groups are those in which R_{11} is hydrogen, R_6O , or optionally substituted lower alkyl and R_{12} is as defined above. Most preferred amidino groups are those in which R_{11} and R_{12} are hydrogen.

25 "Carbamate" means a group of formula $Y_1Y_2C(O)NH\text{---}$ wherein Y_1 is as defined herein; Y_2 is selected from optionally substituted alkoxy or optionally substituted aryloxy. "Alkylcarbamate" means a group of formula $Y_1Y_2C(O)NH\text{---}$ wherein Y_1 and Y_2 are independently alkyl. More preferred alkylcarbamate groups are methylcarbamate, ethylcarbamate, t-butylcarbamate, benzylcarbamate and phenylcarbamate.

"Aminoalkylamino" means a $Y_1Y_2N\text{---alkylene--}(Y_2)N\text{---}$ group wherein Y_1 , Y_2 and alkylene are as defined herein.

30 "Aryloxycarbonylalkyl" means a aryl-O-C(O)-alkylene group wherein the aryl portion and alkylene portion are as defined herein.

"Heteroaryloxycarbonylalkyl" means a hetroaryl-O-C(O)-alkylene group wherein the heteroaryl portion and alkylene portion are as defined herein.

"Heterocyclooxycarbonylalkyl" means a heterocyclyl-O-C(O)-alkylene group wherein the heterocyclyl portion and alkylene portion are as defined herein.

5 "Heterocyclenyloxycarbonylalkyl" means a heterocyclenyl-O-C(O)-alkylene group wherein the heterocyclenyl portion and alkylene portion are as defined herein.

"Basic nitrogen atom" means an sp^2 or sp^3 hybridized nitrogen atom having a non-bonded pair of electrons which is capable of being protonated. Examples of basic nitrogen atoms, which may be optionally substituted where possible, include those in heteroaryl, 10 heterocyclyl, heterocyclenyl, fused arylheterocyclyl, fused arylheterocyclenyl, fused heteroarylcycloalkyl, fused heteroarylcycloalkenyl, fused heteroarylheterocyclyl, fused heterocyclylheterocyclenyl, imino, amino, isourea, acylhydrazino, guanidino and amidino groups.

"Cycloalkyl" means a non-aromatic mono- or multicyclic hydrocarbon ring system of 15 about 3 to about 10 carbon atoms. Representative monocyclic cycloalkyl rings include cyclopentyl, cyclohexyl, cycloheptyl, and the like. Representative multicyclic cycloalkyl rings include decalynyl, norbornyl, adamantyl, and the like. The cycloalkyl group is optionally substituted with one or more "cycloalkyl group substituents" which may be the same or different, where "cycloalkyl group substituent" includes oxo (O=), thioxo (S=), methylene ($H_2C=$), oxime 20 (HO-N=), alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, aralkyl, heteroaralkyl, hydroxy, hydroxyalkyl, alkoxy, aryloxy, aralkoxy, acyl, aroyl, halo, nitro, cyano, carboxy, alkoxycarbonyl, aryloxy carbonyl, aralkoxycarbonyl, acylamino, aroylamino, alkylsulfonyl, arylsulfonyl, heteroarylsulfonyl, alkylsulfinyl, arylsulfinyl, heteroarylsulfinyl, alkylthio, arylthio, heteroarylthio, aralkylthio, heteroaralkylthio, amidino, 25 amino, carbamoyl, or sulfamoyl. Preferred cycloalkyl group substituents are amino and amidino.

"Cycloalkenyl" means a non-aromatic monocyclic or multicyclic hydrocarbon ring system containing a carbon-carbon double bond and having about 3 to about 10 carbon atoms. The cycloalkenyl group is optionally substituted by one or more cycloalkyl group substituents as 30 defined herein. Representative monocyclic cycloalkenyl rings include cyclopentenyl, cyclohexenyl or cycloheptenyl, and the like. A representative multicyclic cycloalkenyl ring is norbornylenyl. Preferred cycloalkenyl group substituents are amino and amidino.

"Carboxy" means a group of formula $HO(O)C-$ (carboxylic acid group).

35 "Heterocyclyl" means a non-aromatic saturated monocyclic or multicyclic ring system of about 3 to about 10 ring atoms wherein the ring system contains one or more element(s) other

than carbon. Preferred heterocyclyl comprise about 5 to about 7 ring atoms, more preferred 5 to 6 ring atoms, wherein one or two of the ring atoms is/are independently selected from oxygen, nitrogen or sulfur respectively. "Aza", "oxa" or "thia", when used as a prefix before heterocyclyl means that the ring system contains at least one nitrogen, oxygen and sulfur atom. For

5 example, "azaheterocyclyl" means a heterocyclyl group wherein one or more of the atoms in the ring system is/are nitrogen. The heterocyclyl group is optionally substituted with one or more heterocyclyl group substituents which may be the same or different, where "heterocyclyl group substituent" includes oxo (O=), thioxo (S=), methylene (H₂C=), oxime (HO-N=), alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, aralkyl, 10 heteroaralkyl, hydroxy, hydroxyalkyl, alkoxy, aryloxy, aralkoxy, acyl, aroyl, halo, nitro, cyano, carboxy, alkoxycarbonyl, aryloxy carbonyl, aralkoxycarbonyl, acylamino, aroylamino, alkylsulfonyl, arylsulfonyl, heteroarylsulfonyl, alkylsulfinyl, arylsulfinyl, heteroarylsulfinyl, alkylthio, arylthio, heteroarylthio, aralkylthio, heteroaralkylthio, amino, carbamoyl, and sulfamoyl. Preferred heterocyclyl group substituents include amino, amidino, halogen, hydroxy, 15 alkoxycarbonylalkyl and carboxyalkyl. Representative heterocyclyl groups include piperidyl, pyrrolidinyl, piperazinyl, pyrazolidinyl, imidazolyl, hexamethyleneimine, homopiperazine, tetrahydrofuryl, morpholinyl, thiomorpholinyl, thiazolidinyl, 1,3-dioxolanyl, 1,4-dioxanyl, 1,4-dithianyl, 1,3,5-trithianyl, tetrahydrothienyl, tetrahydrothiopyranyl, quinuclidinyl, and the like. The thio or nitrogen moiety of the heterocyclyl may also be optionally oxidized to the 20 corresponding S-oxide, S,S-dioxide or N-oxide.

"Heterocyclenyl" means a heterocyclyl group as defined herein which contains at least one carbon-carbon or carbon-nitrogen double bond. "Aza", "oxa" or "thia", when used as a prefix before heterocyclenyl group means that the ring system contains at least one nitrogen, oxygen or sulfur atom respectively. The heterocyclenyl group is optionally substituted with one 25 or more heterocyclyl group substituents as defined herein. Representative heterocyclenyl groups include 2H-pyrrolyl, 2-pyrrolinyl, 3-pyrrolinyl, 2-imidazolyl, 2-pyrazolyl, 2H-pyranyl, 1,2-dihydropyridyl, 1,4-dihydropyridyl, 1,2,3,4-tetrahydropyridyl, tetrahydrothiophenyl, tetrahydrothiopyranyl, and the like. Preferred heterocyclenyl group substituents include amino, amidino, halogen, hydroxy, oxo, thioxo, methylene, oxime, alkoxycarbonylalkyl and 30 carboxyalkyl. The thio or nitrogen moiety of the heterocyclyl may also be optionally oxidized to the corresponding N-oxide, S-oxide or S,S-dioxide.

"Aryl" means a 6 to 10 membered aromatic monocyclic or multicyclic hydrocarbon ring system. The aryl group is optionally substituted with one or more "aryl group substituents" which may be the same or different, where "aryl group substituent" includes alkyl, aryl, 35 heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, aralkyl,

heteroaralkyl, aryldiazo, heteroaryldiazo, hydroxy, alkylcarbamate, acylhydrazino, alkoxy, aryloxy, aralkoxy, acyl, aroyl, halo, nitro, cyano, carboxy, alkoxycarbonyl, aryloxy carbonyl, aralkoxycarbonyl, acylamino, aroylamino, alkylsulfonyl, arylsulfonyl, heteroarylsulfonyl, alkylsulfinyl, arylsulfinyl, heteroarylsulfinyl, alkylthio, arylthio, heteroarylthio, aralkylthio, heteroaralkylthio, arylazo, heteroarylazo, amino, amidino, alkylamino, carbamoyl, and sulfamoyl. Preferred aryl groups are optionally substituted phenyl or optionally substituted naphthyl. Preferred aryl group substituents include alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, carboxy, sulfamoyl, alkylcarbamate, hydroxy, acyl, aroyl, halo, nitro, cyano, alkoxycarbonyl, acylamino, alkylthio, alkylamino, amino, carbamoyl, thiocarbamoyl and amidino.

"Heteroaryl" means about a 5- to about a 10- membered aromatic monocyclic or multicyclic ring system wherein one or more of the atoms in the ring system is/are element(s) other than carbon. Preferred heteroaryl groups contain one to about 4 heteroatoms selected from oxygen, nitrogen and sulfur. "Aza", "oxa" or "thia", when used as a prefix before heteroaryl means that the ring system contains at least one nitrogen, oxygen or sulfur atom. The heteroaryl group is optionally substituted with one or more aryl group substituents as defined herein. Representative heteroaryl groups include pyrrolyl, pyrazinyl, furyl, thienyl, pyridyl, pyrimidyl, pyridazinyl, isoxazolyl, isothiazolyl, oxazolyl, thiazolyl, pyrazolyl, triazolyl, oxadiazolyl, thiadiazolyl, thienopyridyl, thienopyrolyl, thieno[3,2-d]pyrimidyl, pyrrolopyridyl, furanopyridyl, furazanyl, quinoxalanyl, quinazolinyl, quinoliziny, imidazo[1,2-a]pyridyl, phthalaziny, imidazo[2,1-b]thiazolyl, benzofuranyl, indolyl, isoindolyl, indoliziny, indazolyl, azaindolyl, benzimidazolyl, benzothienyl, benzisoxazolyl, benzothiazolyl, puriny, benzotriazolyl, 1,8-naphthyridiny, pteridiny, quinoliny, imidazolyl, isoquinoliny, cinnoliny, triaziny, benzotriaziny, and the like. Preferred heteroaryl group substituents include hydrogen, alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, hydroxy, acyl, aroyl, halo, nitro, cyano, carboxy, acylhydrazino, alkoxycarbonyl, acylamino, alkylthio, alkylamino, amino, carbamoyl, thiocarbamoyl and amidino. When the heteroaryl groups contains a nitrogen atom, the nitrogen atom may be oxidized to the N-oxide.

"Fused arylcycloalkyl" means a fused aryl and cycloalkyl, wherein the aryl and cycloalkyl portions are as defined herein. Preferred fused arylcycloalkyls groups are those wherein the aryl thereof is phenyl and the cycloalkyl consists of about 5 to about 6 carbon atoms. Representative fused phenylcycloalkyl groups include 1,2,3,4-tetrahydronaphthyl, indanyl, and the like. The fused arylcycloalkyl group is optionally substituted with one or more fused arylcycloalkyl group substituents selected from, alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, aralkyl, heteroaralkyl, aryldiazo,

heteroaryldiazo, hydroxy, hydroxyalkyl, alkoxy, aryloxy, aralkoxy, acyl, aroyl, halo, nitro, cyano, carboxy, alkoxycarbonyl, aryloxy carbonyl, aralkoxycarbonyl, acylamino, aroylamino, alkylsulfonyl, arylsulfonyl, heteroarylsulfonyl, alkylsulfinyl, arylsulfinyl, heteroarylsulfinyl, alkylthio, arylthio, heteroarylthio, aralkylthio, heteroaralkylthio, arylazo, heteroarylazo, amino, alkylamino, carbamoyl and sulfamoyl. The cycloalkyl moiety is further optionally substituted with oxo (O=), thioxo (S=), methylene (H₂C=), or oxime (HO-N=). Preferred fused phenylcycloalkyl group substituents include alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, hydroxy, acyl, aroyl, halo, nitro, cyano, alkoxycarbonyl, acylamino, alkylthio, alkylamino, amino, carbamoyl, thiocarbamoyl and amidino.

"Fused arylcycloalkenyl" means a fused aryl and cycloalkenyl, wherein the aryl and cycloalkenyl portions are as defined herein. Preferred fused arylcycloalkenyl groups are those wherein the aryl thereof is phenyl and the cycloalkenyl consists of about 5 to about 6 carbon atoms. The fused arylcycloalkenyl is optionally substituted with one or more fused arylcycloalkyl group substituents as defined herein. Representative fused phenylcycloalkenyl groups include 1,2-dihydronaphthyl, indenyl, and the like. The cycloalkyl moiety is further optionally substituted with oxo (O=), thioxo (S=), methylene (H₂C=), oxime (HO-N=). Preferred substituents include alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, hydroxy, acyl, aroyl, halo, nitro, cyano, alkoxycarbonyl, acylamino, alkylthio, alkylamino, amino, carbamoyl, thiocarbamoyl and amidino.

"Fused arylheterocyclyl" means a fused aryl and heterocyclyl, wherein the aryl and heterocyclyl portions are as defined herein. Preferred fused arylheterocyclyl groups are those wherein the aryl portion thereof is phenyl and the heterocyclyl portion consists of about 5 to about 7 ring atoms, more preferred 5 to 6 ring atoms, wherein one or two of the ring atoms is/are independently selected from oxygen, nitrogen and sulfur. "Aza", "oxa" or "thia", when used as a prefix before the heterocyclyl portion of the fused arylheterocyclyl means that the heterocyclyl contains at least one nitrogen, oxygen or sulfur atom. Representative preferred fused phenylheterocyclyl ring systems include indolyl, 1,2,3,4-tetrahydroisoquinolyl, 1,2,3,4-tetrahydroquinolyl, 2,3-dihydrobenzofuran, 1H-2,3-dihydroisoindolyl, 2,3-dihydrobenz[f]isoindolyl, 1,2,3,4-tetrahydrobenz[g]isoquinolyl, and the like. The fused phenylheterocyclyl group is optionally substituted with one or more fused phenylcycloalkyl group substituents as defined herein. The heterocyclyl portion is further optionally substituted with oxo (O=), thioxo (S=), methylene (H₂C=) or oxime (HO-N=). Preferred substituents include alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, hydroxy, acyl, aroyl, halo, nitro, cyano, alkoxycarbonyl, acylamino, alkylthio, alkylamino, amino,

carbamoyl, thiocarbamoyl and amidino. The nitrogen or sulphur atom of the heterocyclyl may also be optionally oxidized to the corresponding N-oxide, S-oxide or S,S-dioxide.

"Fused arylheterocyclenyl" means a fused aryl and heterocyclenyl, wherein the aryl and heterocyclenyl portions are as defined herein. "Aza", "oxa" or "thia", when used as a prefix before the heterocyclenyl portion of the fused arylheterocyclenyl group means that the heterocyclenyl portion contains at least one nitrogen, oxygen or sulfur atom. Preferred fused arylheterocyclenyl groups are those wherein the aryl thereof is phenyl and the heterocyclenyl consists of about 5 to 6 ring atoms wherein one or two of the ring atoms is/are independently selected from oxygen, nitrogen and sulfur. Representative preferred fused arylheterocycloalkenyl ring systems include 3H-indolynyl, 3H-quinazolin-4-one, 1,1-dioxo-benzo[d]isothiazolyl, 1H-2-oxoquinolyl, 2H-1-oxoisquinolyl, and the like. The fused arylheterocyclenyl group is optionally substituted with one or more fused arylcycloalkyl group substituents as defined herein. The heterocyclenyl portion is further optionally substituted with oxo (O=), thioxo (S=), methylene (H₂C=) or oxime (HO-N=). Preferred substituents include alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, hydroxy, acyl, aroyl, halo, nitro, cyano, alkoxycarbonyl, acylamino, alkylthio, alkylamino, amino, carbamoyl, thiocarbamoyl and amidino. The nitrogen or sulphur atom of the heterocyclenyl is optionally oxidized to the corresponding N-oxide, S-oxide or S,S-dioxide.

"Fused heteroarylcyaloalkyl" means a fused heteroaryl and cycloalkyl, wherein the heteroaryl and cycloalkyl portions are as defined herein. "Aza", "oxa" or "thia", when used as a prefix before the heteroaryl portion of the fused heteroarylcyaloalkyl group means that the heteroaryl portion contains at least one nitrogen, oxygen or sulfur atom. Preferred fused heteroarylcyaloalkyl groups are those wherein the heteroaryl portion thereof consists of about 5 to about 6 ring atoms in which one or two of the ring atoms are independently selected from oxygen, nitrogen and sulfur and the cycloalkyl consists of about 5 to about 6 ring atoms. Representative preferred fused heteroarylcyaloalkyl groups include 5,6,7,8-tetrahydroisoquinolyl, 5,6,7,8-tetrahydroquinoxalynyl, 5,6,7,8-tetrahydroquinazolyl, 4,5,6,7-tetrahydro-1H-benzimidazolyl, 4,5,6,7-tetrahydrobenzoxazolyl, 1H-4-oxa-1,5-diazanaphthalen-2-onyl, 1,3-dihydroimidazole-[4,5]-pyridin-2-onyl, 5,6,7,8-tetrahydrobenzothiazolyl, 5,6-dihydro-4H-benzothiazol-7-one, and the like. The fused heteroarylcyaloalkyl group is optionally substituted with one or more fused phenylcycloalkyl group substituents as defined herein. The cycloalkyl moiety is further optionally substituted with oxo (O=), thioxo (S=), methylene (H₂C=) or oxime (HO-N=). Preferred substituents include alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, hydroxy, acyl, aroyl, halo, nitro, cyano, alkoxycarbonyl, acylamino, alkylthio, alkylamino, amino, carbamoyl, thiocarbamoyl and amidino.

The nitrogen atom of the heteroaryl portion of the fused heteroarylcycloalkyl group is optionally oxidized to the N-oxide.

"Fused heteroarylcycloalkenyl" means a 5- or 6-membered heteroaryl fused with a cycloalkenyl ring. "Aza", "oxa" or "thia", when used as a prefix before the heteroaryl portion of the fused heteroarylcycloalkenyl means that the cycloalkenyl contains at least one nitrogen, oxygen or sulfur atom. Preferred fused heteroarylcycloalkenyls are those wherein the heteroaryl thereof consists of about 5 to about 6 ring atoms in which one or two of the ring atoms are independently selected from oxygen, nitrogen and sulfur and the cycloalkenyl consists of about 5 to about 6 ring atoms. Representative preferred fused

heteroarylcycloalkenyl include 5,6-dihydroisoquinolyl, 5,6-dihydroquinoxalyl, 5,6-dihydroquinazolyl, 4,5-dihydro-1H-benzimidazolyl, 4,5-dihydrobenzoxazolyl, and the like. The fused heteroarylcycloalkenyl is optionally substituted with one or more fused phenylcycloalkyl group substituents as defined herein. The cycloalkenyl moiety is further optionally substituted with oxo (O=), thioxo (S=), methylene (H₂C=) or oxime (HO-N=).

Preferred substituents include alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, hydroxy, acyl, aroyl, halo, nitro, cyano, alkoxycarbonyl, acylamino, alkylthio, alkylamino, amino, carbamoyl, thiocarbamoyl and amidino. The nitrogen atom of the heteroaryl portion of the fused heteroarylcycloalkyl is optionally oxidized to the N-oxide.

"Fused heteroarylheterocyclyl" means a heteroaryl ring fused with a heterocyclyl ring wherein the heteroaryl and heterocyclyl portions are as defined herein. "Aza", "oxa" or "thia", when used as a prefix before the heteroaryl or heterocyclyl portion of the fused heteroarylheterocyclyl group means that the heteroaryl or heterocyclyl portion contains at least one nitrogen, oxygen or sulfur atom. Preferred fused heteroarylheterocyclyl groups are ring systems wherein one or two of the ring atoms of the heteroaryl are independently selected from oxygen, nitrogen and sulfur and the heterocyclyl portion consists of about 5 to about 6 ring atoms in which one or two of the ring atoms are independently selected from oxygen, nitrogen and sulfur. Representative fused heteroarylheterocyclyl groups include 4,7-dihydro-5H-thiazolo[5,4-c]pyridin-6-one, 5,6,7,8-tetrahydro-thiazolo[4,5-c]azepin-4-one,

2,3-dihydro-1H pyrrol[3,4-b]quinolin-2-yl, 1,2,3,4-tetrahydrobenz [b][1,7]naphthyridin-2-yl, 1,2,3,4-tetrahydrobenz [b][1,6]naphthyridin-2-yl, 1,2,3,4-tetrahydro-9H-pyrido[3,4-b]indol-2-yl, 1,2,3,4-tetrahydro-9H-pyrido[4,3-b]indol-2-yl, 2,3-dihydro-1H-pyrrolo[3,4-b]indol-2-yl, 1H-2,3,4,5-tetrahydroazepino[3,4-b]indol-2-yl, 1H-2,3,4,5-tetrahydroazepino[4,3-b]indol-3-yl, 1H-2,3,4,5-tetrahydroazepino[4,5-b]indol-2-yl, 5,6,7,8-tetrahydro[1,7]naphthyridinyl, 1,2,3,4-tetrahydro[2,7]naphthyridyl, 2,3-dihydro[1,4]dioxino[2,3-b]pyridyl, 2,3-dihydro[1,4]dioxino[2,3-b]pyridyl, 3,4-dihydro-2H-1-oxa-4,6-diazanaphthalenyl,

4,5,6,7-tetrahydro-3H-imidazo[4,5-c]pyridyl, 6,7-dihydro-5,8-diazanaphthalenyl, and the like.

The fused heteroarylheterocyclyl group is optionally substituted with one or more fused arylcycloalkyl group substituents as defined herein. The heterocyclyl portion is further optionally substituted with oxo (O=), thioxo (S=), methylene (H₂C=) or oxime (HO-N=).

- 5 Preferred substituents include alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl, acylhydrazino, hydroxy, acyl, aroyl, halo, nitro, cyano, alkoxycarbonyl, acylamino, alkylthio, alkylamino, amino, carbamoyl, thiocarbamoyl and amidino. The nitrogen atom of the heteroaryl portion is optionally oxidized to the N-oxide. The nitrogen or sulphur atom of the heterocyclyl portion is optionally oxidized to the corresponding N-oxide, S-oxide or S,S-dioxide.
- 10 "Fused heteroarylheterocyclenyl" means a fused heteroaryl and heterocyclenyl, wherein the heteroaryl and heterocyclenyl portions are as defined herein. "Aza", "oxa" or "thia", when used as a prefix before the heteroaryl or heterocyclenyl portion of the fused heteroarylheterocyclenyl group means that the heteroaryl or heterocyclenyl portion contains at least one nitrogen, oxygen or sulfur atom. Preferred fused heteroarylheterocyclenyl groups are
- 15 ring systems wherein the heteroaryl portion thereof consists of about 5 to about 6 ring atoms in which one or two of the ring atoms are independently selected from oxygen, nitrogen and sulfur and the heterocyclenyl portion consists of about 5 to about 6 ring atoms in which one or two of the ring atoms are independently selected from oxygen, nitrogen and sulfur. Representative fused heteroarylheterocyclenyl groups include 7,8-dihydro[1,7]naphthyridinyl, 1,2-
- 20 dihydro[2,7]naphthyridinyl, 6,7-dihydro-3H-imidazo[4,5-c]pyridyl, and the like. The fused heteroarylheterocyclenyl group is optionally substituted with one or more fused arylcycloalkyl group substituents as defined herein. The heterocyclenyl portion is further optionally substituted with oxo (O=), thioxo (S=), methylene (H₂C=) or oxime (HO-N=). Preferred substituents include alkyl, aryl, heteroaryl, heterocyclyl, heterocyclenyl, cycloalkyl, cycloalkenyl,
- 25 acylhydrazino, hydroxy, acyl, aroyl, halo, nitro, cyano, alkoxycarbonyl, acylamino, alkylthio, alkylamino, amino, carbamoyl, thiocarbamoyl and amidino. The nitrogen atom of the heteroaryl portion is optionally oxidized to the N-oxide. The nitrogen or sulphur atom of the heterocyclenyl is optionally oxidized to the corresponding N-oxide, S-oxide or S,S-dioxide.

- "Aralkyl" means an aryl-alkyl- group in which the aryl portion and alkyl portion are as defined herein. Preferred aralkyl groups contain a lower alkyl moiety. Representative aralkyl groups include benzyl, 2-phenethyl and naphthalenemethyl.
- 30

- "Heteroaralkyl" means a heteroaryl-alkyl- group in which the heteroaryl portion and alkyl portion are as defined herein. Preferred heteroaralkyl groups contain a lower alkyl moiety. Representative heteroaralkyl groups may contain thienylmethyl, pyridylmethyl, imidazolylmethyl and pyrazinylmethyl.
- 35

"Aralkenyl" means an aryl-alkenyl- group in which the aryl portion and alkenyl portion are as defined herein. Preferred aralkenyl groups contain a lower alkenyl moiety. An representative aralkenyl group is 2-phenethenyl.

5 "Heteroaralkenyl" means a heteroaryl-alkenyl- group in which the heteroaryl portion and alkenyl portion are as defined herein. Preferred heteroaralkenyls contain a lower alkenyl moiety. Representative heteroaralkenyl groups may contain thienylethenyl, pyridylethenyl, imidazolylethenyl and pyrazinylethenyl.

10 "Hydroxyalkyl" means a HO-alkylene- group in which the alkylene portion is as defined herein. Preferred hydroxyalkyl groups contain lower alkylene. Representative hydroxyalkyl groups include hydroxymethyl and 2-hydroxyethyl.

"Acyl" means an H-CO- or alkyl-CO- group in which the alkyl portion is as defined herein. Preferred acyl groups contain a lower alkyl. Representative acyl groups include formyl, acetyl, propanoyl, 2-methylpropanoyl, butanoyl and palmitoyl.

15 "Aroyl" means an aryl-CO- group in which the aryl portion is as defined herein. Representative aroyl groups include benzoyl and 1- and 2-naphthoyl.

"Aryldiazo" means an aryl-N=N- group in which the aryl portion is as defined herein. Representative aryldiazo groups include phenyldiazo and naphthyldiazo.

"Heteroaroyl" means an means a heteroaryl-CO- group in which the heteroaryl portion is as defined herein. Representative heteroaryl groups include thiophenoyl and pyridinoyl.

20 "Heteroaryldiazo" means a heteroaryl-N=N- group in which the heteroaryl group is as defined herein. Representative heteroaryldiazo groups include pyridyldiazo and thienyldiazo.

"Alkoxy" means an alkyl-O- group in which the alkyl portion is as defined herein. Representative alkoxy groups include methoxy, ethoxy, n-propoxy, i-propoxy, n-butoxy and heptoxy.

25 "Aryloxy" means an aryl-O- group in which the aryl portion is as defined herein. Representative aryloxy groups include phenoxy and naphthoxy.

"Aralkyloxy" means an aralkyl-O- group in aralkyl portion is as defined herein. Representative aralkyloxy groups include benzyloxy and 1- or 2-naphthalenemethoxy.

30 "Alkylthio" means an alkyl-S- group in which alkyl portion is as defined herein. Representative alkylthio groups include methylthio, ethylthio, i-propylthio and heptylthio.

"Arylthio" means an aryl-S- group in which the aryl portion is as defined herein. Representative arylthio groups include phenylthio and naphthylthio.

"Aralkylthio" means an aralkyl-S- group in which the aralkyl portion is as defined herein. A representative aralkylthio group is benzythio.

"Amino" means a group of formula Y_1Y_2N - wherein Y_1 and Y_2 are defined herein.

Preferred amino groups include amino (H_2N -), methylamino, dimethylamino, diethylamino, benzylamino, phenethylamino, 5-aminoindolyl, 2-amino-2-thiazolynyl, N-(2-aminoethyl)morpholine, 2(aminomethyl)pyridine, or 4(aminomethyl)pyridine.

5 "Aminoalkyl" means a Y_1Y_2N -alkylene- group wherein Y_1 , Y_2 and the alkylene portion are defined herein.

"Alkoxycarbonyl" and "alkyloxycarbonyl" means an alkyl-O-CO- group wherein the alkyl portion is as defined herein. Representative alkoxycarbonyl groups include methoxycarbonyl, ethoxycarbonyl, or t-butyloxycarbonyl.

10 "Heterocyclylalkyloxycarbonyl" means an heterocyclyl-alkyloxycarbonyl group wherein the heterocyclyl portion and alkyloxycarbonyl portion are as defined herein. A representative example of a heterocyclylalkyloxycarbonyl group is pyrrolidinylethoxycarbonyl.

"Heterocyclenylalkyloxycarbonyl" means an heterocyclenyl-alkyloxycarbonyl group wherein the heterocyclenyl portion and alkyloxycarbonyl portion are as defined herein. A
15 representative example of a heterocyclenylalkyloxycarbonyl group is pyrrolinylethoxycarbonyl.

"Heteroaralkyloxycarbonyl" means an heteroaryl-alkyloxycarbonyl group wherein the heteroaryl portion and alkyloxycarbonyl portion are as defined herein. A representative example of a heteroaralkyloxycarbonyl group is pyridylethoxycarbonyl.

"Arylalkyloxycarbonyl" means an aryl-alkyloxycarbonyl group wherein the aryl portion
20 and alkyloxycarbonyl portion are as defined herein. A representative example of a aralkyloxycarbonyl group is phenylethoxycarbonyl.

"Cycloalkylalkyloxycarbonyl" means a cycloalkyl-alkyloxycarbonyl group wherein the cycloalkyl portion and alkyloxycarbonyl portion are as defined herein. A representative example of a ar cycloalkylalkyloxycarbonyl group is cyclohexylethoxycarbonyl.

25 "Cycloalkenylalkyloxycarbonyl" means a cycloalkenyl-alkyloxycarbonyl group wherein the cycloalkenyl portion and alkyloxycarbonyl portion are as defined herein. A representative example of a ar cycloalkenylalkyloxycarbonyl group is cyclohexenylethoxycarbonyl.

"Alkoxycarbonylalkyl" means an alkyl-O-CO-alkylene- group wherein alkyl portion and alkylene portion are defined herein.

30 "Aryloxycarbonyl" means an aryl-O-CO- group wherein aryl portion is as defined herein. Representative aryloxycarbonyl groups include phenoxycarbonyl and naphthoxycarbonyl.

"Aralkoxycarbonyl" means an aralkyl-O-CO- group wherein aralkyl portion is as defined herein. A representative aralkoxycarbonyl group is benzyloxycarbonyl.

"Carbamoyl" means a group of formula Y_1Y_2NCO- wherein Y_1 and Y_2 are defined herein. Representative carbamoyl groups are carbamoyl (H_2NCO-) and dimethylaminocarbamoyl (Me_2NCO-).

"Heterocyclalkylcarbamoyl" means a heterocyclalkylene-carbamoyl wherein the
5 heterocyclalkyl, alkylene and carbamoyl portions are as defined herein. A representative example of a heterocyclalkylenecarbamoyl group is pyrrolidinylethylcarbamoyl.

"Heterocyclenylalkylcarbamoyl" means a heterocyclenyl-alkylene-carbamoyl wherein the heterocyclenyl, alkylene and carbamoyl portions are as defined herein. A representative example of a heterocyclenylalkylenecarbamoyl group is pyrrolinylethylcarbamoyl.

10 "Heteroaralkylcarbamoyl" means a heteroaralkylene-carbamoyl wherein the heteroaralkyl, alkylene and carbamoyl portions are as defined herein. A representative example of a heteroaralkylenecarbamoyl group is pyridinylethylcarbamoyl.

"Arylalkylcarbamoyl" means an aryl-alkylene-carbamoyl wherein the aryl, alkylene and carbamoyl portions are as defined herein. A representative example of an aralkylenecarbamoyl
15 group is phenylethylcarbamoyl.

"Cycloalkylalkylcarbamoyl" means a cycloalkyl-alkylene-carbamoyl wherein the cycloalkyl, alkylene and carbamoyl portions are as defined herein. A representative example of a cycloalkylalkylenecarbamoyl group is cyclohexylethylcarbamoyl.

"Cycloalkenylalkylcarbamoyl" means a cycloalkenyl-alkylene-carbamoyl wherein the
20 cycloalkenyl, alkylene and carbamoyl portions are as defined herein. A representative example of a cycloalkylalkylenecarbamoyl group is cyclohexenylethylcarbamoyl.

"Sulfamoyl" means a group of formula $Y_1Y_2NSO_2-$ wherein Y_1 and Y_2 are defined herein. Representative sulfamoyl groups are aminosulfamoyl (H_2NSO_2-) and dimethylaminosulfamoyl (Me_2NSO_2-).

25 "Acylamino" means an acyl-NH- group wherein the acyl portion is as defined herein.

"Aroylamino" means an aroyl-NH- group wherein the aroyl portion is as defined herein.

"Alkylsulfonyl" means an alkyl-SO₂- group wherein the alkyl portion is as defined herein.

Preferred alkylsulfonyl groups are those in which the alkyl group is lower alkyl.

"Alkylsulfinyl" means an alkyl-SO- group wherein the alkyl portion is as defined herein.

30 Preferred alkylsulfinyl groups are those in which the alkyl portion is lower alkyl.

"Arylsulfonyl" means an aryl-SO₂- group wherein the aryl portion is as defined herein.

"Arylsulfinyl" means an aryl-SO- group wherein the aryl portion is as defined herein.

"Halo" or "halogen" means fluoro, chloro, bromo, or iodo. Preferred are fluoro, chloro or bromo, and more preferred are fluoro or chloro.

"Nitrogen protecting group" means an easily removable group which is known in the art to protect an amino group against undesirable reaction during synthetic procedures and to be selectively removable. The use of N-protecting groups is well known in the art for protecting groups against undesirable reactions during a synthetic procedure and many such protecting groups are known, CF, for example, T.H. Greene and P.G.M. Wuts, Protective Groups in Organic Synthesis, 2nd edition, John Wiley & Sons, New York (1991), incorporated herein by reference. Preferred N-protecting groups are acyl, including formyl, acetyl, chloroacetyl, trichloroacetyl, o-nitrophenylacetyl, o-nitrophenoxyacetyl, trifluoroacetyl, acetoacetyl, 4-chlorobutyryl, isobutyryl, o-nitrocinnamoyl, picolinoyl, acylisothiocyanate, aminocaproyl, benzoyl and the like, and acyloxy including methoxycarbonyl, 9-fluorenylmethoxycarbonyl, 2,2,2-trifluoroethoxycarbonyl, 2-trimethylsilylethoxycarbonyl, vinylloxycarbonyl, allyloxycarbonyl, t-butyloxycarbonyl (BOC), 1,1-dimethylpropynyloxycarbonyl, benzyloxycarbonyl (CBZ), p-nitrophenylsulfinyl, p-nitrobenzyloxycarbonyl, 2,4-dichlorobenzyloxycarbonyl, allyloxycarbonyl (Alloc), and the like.

"Compounds of the invention", and equivalent expressions, are meant to embrace compounds of general formula I or formula II as hereinbefore described, which expression includes the prodrugs, the pharmaceutically acceptable salts, and the solvates, e.g. hydrates, where the context so permits. It is understood that the activity of individual compounds of formula I or formula II will vary depending on the individual compound and assay employed.

Compounds of the invention as used herein includes all compounds of formula I or formula II having an in-vitro activity of greater than 10% at 3.9 μ M in the Factor Xa in vitro enzyme assay described herein. Similarly, reference to intermediates, whether or not they themselves are claimed, is meant to embrace their salts, and solvates, where the context so permits. For the sake of clarity, particular instances when the context so permits are sometimes indicated in the text, but these instances are purely illustrative and it is not intended to exclude other instances when the context so permits.

"Prodrug" means a form of the compound of formula I or formula II which may or may not itself be biologically active but which may be converted, for example by metabolic, solvolytic, or other physiological means, to a biologically active chemical entity, and is suitable for administration to a patient without undue toxicity, irritation, allergic response, and the like, and effective for their intended use, including ketal, ester and zwitterionic forms. A prodrug is transformed in vivo to yield the parent compound of the above formula, for example by hydrolysis in blood. A thorough discussion is provided in T. Higuchi and V. Stella, Pro-drugs as Novel Delivery Systems, Vol. 14 of the A. C. S. Symposium Series, and in Edward B. Roche,

ed., Bioreversible Carriers in Drug Design, American Pharmaceutical Association and Pergamon Press, 1987, both of which are incorporated herein by reference.

"Solvate" means a physical association of a compound of this invention with one or more solvent molecules. This physical association involves varying degrees of ionic and covalent bonding, including hydrogen bonding. In certain instances the solvate will be capable of isolation, for example when one or more solvent molecules are incorporated in the crystal lattice of the crystalline solid. "Solvate" encompasses both solution-phase and isolable solvates. Representative solvates include ethanolates, methanolates, and the like. "Hydrate" is a solvate wherein the solvent molecule(s) is/are H₂O.

In a specific embodiment, the term "about" or "approximately" means within 20%, preferably within 10%, and more preferably within 5% of a given value or range

Where the compound of this invention is substituted with a basic moiety, acid addition salts may be formed. The acids which can be used to prepare the acid addition salts include preferably those which produce, when combined with the free base, pharmaceutically acceptable salts, that is, salts whose anions are non-toxic to the patient in pharmaceutical doses of the salts, so that the beneficial effects inherent in the free base are not vitiated by side effects ascribable to the anions. Although pharmaceutically acceptable salts of said basic compounds are preferred, all acid addition salts are useful as sources of the free base form even if the particular salt, per se, is desired only as an intermediate product as, for example, when the salt is formed only for purposes of purification, and identification, or when it is used as intermediate in preparing a pharmaceutically acceptable salt by ion exchange procedures.

Pharmaceutically acceptable salts within the scope of the invention are those derived from the following acids: mineral acids such as hydrochloric acid, sulfuric acid, phosphoric acid and sulfamic acid; and organic acids such as acetic acid, citric acid, lactic acid, tartaric acid, malonic acid, methanesulfonic acid, ethanesulfonic acid, benzenesulfonic acid, p-toluenesulfonic acid, cyclohexylsulfamic acid, quinic acid, and the like. The corresponding acid addition salts comprise the following: hydrohalides, e.g. hydrochloride and hydrobromide, sulfate, phosphate, nitrate, sulfamate, acetate, citrate, lactate, tartarate, malonate, oxalate, salicylate, propionate, succinate, fumarate, maleate, methylene-bis-β-hydroxynaphthoates, gentisates, mesylates, isethionates and di-p-toluoyletartratesmethanesulfonate, ethanesulfonate, benzenesulfonate, p-toluenesulfonate, cyclohexylsulfamate and quinate, respectively.

Acid addition salts of the compounds of this invention are prepared by reaction of the free base with the appropriate acid by the application or adaptation of known methods. For example, the acid addition salts of the compounds of this invention are prepared either by

dissolving the free base in aqueous or aqueous-alcohol solution or other suitable solvents containing the appropriate acid and isolating the salt by evaporating the solution, or by reacting the free base and acid in an organic solvent, in which case the salt separates directly or can be obtained by concentration of the solution.

5 The compounds of this invention can be regenerated from the acid addition salts by the application or adaptation of known methods. For example, parent compounds of the invention can be regenerated from their acid addition salts by treatment with an alkali, e.g. aqueous sodium bicarbonate solution or aqueous ammonia solution.

Where the compound of the invention is substituted with an acidic moiety, base addition
10 salts may be formed. The bases which can be used to prepare the base addition salts include preferably those which produce, when combined with the free acid, pharmaceutically acceptable salts, that is, salts whose cations are non-toxic to the animal organism in pharmaceutical doses of the salts, so that the beneficial effects inherent in the free acid are not vitiated by side effects ascribable to the cations. Pharmaceutically acceptable salts, including
15 for example alkali and alkaline earth metal salts, within the scope of the invention are those derived from the following bases: sodium hydride, sodium hydroxide, potassium hydroxide, calcium hydroxide, aluminum hydroxide, lithium hydroxide, magnesium hydroxide, zinc hydroxide, ammonia, trimethylammonia, triethylammonia, ethylenediamine, n-methylglucamine, lysine, arginine, ornithine, choline, N,N'-dibenzylethylenediamine,
20 chloroprocaine, diethanolamine, procaine, n-benzylphenethylamine, diethylamine, piperazine, tris(hydroxymethyl)aminomethane, tetramethylammonium hydroxide, and the like.

Metal salts of compounds of the present invention may be obtained by contacting a hydride, hydroxide, carbonate or similar reactive compound of the chosen metal in an aqueous or organic solvent with the free acid form of the compound. The aqueous solvent employed
25 may be water or it may be a mixture of water with an organic solvent, preferably an alcohol such as methanol or ethanol, a ketone such as acetone, an aliphatic ether such as tetrahydrofuran, or an ester such as ethyl acetate. Such reactions are normally conducted at ambient temperature but they may, if desired, be conducted with heating.

Amine salts of compounds of the present invention may be obtained by contacting an
30 amine in an aqueous or organic solvent with the free acid form of the compound. Suitable aqueous solvents include water and mixtures of water with alcohols such as methanol or ethanol, ethers such as tetrahydrofuran, nitriles such as acetonitrile, or ketones such as acetone. Amino acid salts may be similarly prepared.

The compounds of this invention can be regenerated from the base addition salts by the
35 application or adaptation of known methods. For example, parent compounds of the invention

can be regenerated from their base addition salts by treatment with an acid, e.g. hydrochloric acid.

As well as being useful in themselves as active compounds, salts of compounds of the invention are useful for the purposes of purification of the compounds, for example by
5 exploitation of the solubility differences between the salts and the parent compounds, side products and/or starting materials by techniques well known to those skilled in the art.

It will be appreciated that compounds useful according to the present invention may contain asymmetric centers. These asymmetric centers may independently be in either the R or S configuration. It will be apparent to those skilled in the art that certain compounds useful
10 according to the invention may also exhibit geometrical isomerism. It is to be understood that the present invention includes individual stereoisomers and mixtures thereof, including racemic mixtures, of compounds of formula I or formula II hereinabove. Such isomers can be separated from their mixtures, by the application or adaptation of known methods, for example chromatographic techniques and recrystallisation techniques, or they are separately prepared
15 from the appropriate isomers of their intermediates.

Compounds of this invention may also exhibit geometrical isomerism. Geometrical isomers include the cis and trans forms of compounds of the invention having alkenyl or alkenylenyl moieties. The present invention comprises the individual geometrical isomers and stereoisomers and mixtures thereof.

20 For the propose herein it is understood that tautermeric forms are included in the recitation of a given group, e.g., thio/mercapto or oxo/hydroxyl.

Preferred Embodiments

Another preferred aspect of the invention is a compound of formula I, wherein q is 0 and
25 Z is absent.

Another preferred aspect of the invention is a compound of formula I, wherein q is 0, r is 1 and Z is absent.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is optionally substituted heteroaryl, optionally substituted heterocyclyl, optionally substituted
30 heterocyclenyl, optionally substituted cycloalkyl, optionally substituted cycloalkenyl, optionally substituted fused heteroarylheterocyclyl, optionally substituted fused heteroarylheterocyclenyl, optionally substituted fused heteroarylcycloalkenyl, optionally substituted fused heteroarylcycloalkyl, fused arylheterocyclyl, optionally substituted fused arylheterocyclenyl, or optionally substituted aryl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is optionally substituted azaheteroaryl, optionally substituted azaheterocyclyl, optionally substituted azaheterocyclenyl, optionally substituted fused arylazaheteroclylyl, optionally substituted fused arylazaheterocyclenyl, optionally substituted fused heteroarylazaheteroclylyl, optionally substituted fused heteroarylazaheterocyclenyl, optionally substituted fused azaheteroarylcyloalkyl, optionally substituted fused azaheteroarylcyloalkenyl, optionally substituted azaheterocyclyl, or optionally substituted heterocyclenyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is optionally substituted with one or more groups selected from amino, carbamoyl, acylamino, heteroaryl, heterocyclenyl, heterocyclyl, alkyl, alkyloxycarbonyl, amidino, hydroxy, alkoxy, aryl, isourea, guanidino, acylhydrazino, acyl, cyano, carboxy, sulfamoyl, or halo.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is optionally substituted with one of more groups selected from aralkylamino, heteroaralkylamino, heterocyclylalkylamino, heterocyclenylalkylamino, alkylcarbamate, aminoalkylamino, aryloxycarbonylalkyl, heteroaryloxycarbonylalkyl, heterocycloxy carbonylalkyl, heterocyclenyl oxy carbonylalkyl, and alkoxy carbonylalkyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ optionally contains at least substituent selected from oxime and oxo when Cy₂ is cycloalkyl, cycloalkenyl, heterocyclyl, heterocyclenyl, fused arylcycloalkyl, fused arylcycloalkenyl, fused arylheterocyclyl, fused arylheterocyclenyl, fused heteroarylcyloalkyl, fused heteroarylcyloalkenyl, fused heteroarylheterocyclyl or fused heteroarylheterocyclenyl.

Another preferred aspect of the invention is a compound of formula I, wherein R₁, R_{1a}, R₂, R_{2a}, R₄, or R_{4a} are hydrogen.

Another preferred aspect of the invention is a compound of formula I, wherein R₄, and R_{4a} taken together form O or S.

Another preferred aspect of the invention is a compound of formula I, wherein R₄, and R_{4a} taken together form O.

Another preferred aspect of the invention is a compound of formula I, wherein R₁, R_{1a}, R₂ and R_{2a} are hydrogen.

Another preferred aspect of the invention is a compound of formula I, wherein R₁, R_{1a}, R₄ and R_{4a} are hydrogen.

Another preferred aspect of the invention is a compound of formula I, wherein R₄ and R_{4a} are hydrogen.

Another preferred aspect of the invention is a compound of formula I, wherein R₄ is optionally substituted lower alkyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_4 is alkoxyalkyl, alkylthioalkyl, alkylsulfinylalkyl, alkylsulfonylalkyl, alkoxycarbonylalkyl, hydroxyalkyl, acylalkyl, acylaminoalkyl or carbamoylalkyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_2 is
5 optionally substituted lower alkyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_2 and R_{2a} are hydrogen.

Another preferred aspect of the invention is a compound of formula I, wherein R_2 alkoxyalkyl, alkoxycarbonylalkyl, carboxyalkyl, hydroxyalkyl or heterocyclylalkyloxycarbonyl,
10 and R_{2a} is hydrogen.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 and R_{1a} are hydrogen.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 is lower alkyl, carboxy, alkoxycarbonyl or carbamoyl, and R_{1a} is hydrogen.

15 Another preferred aspect of the invention is a compound of formula I, wherein R_1 is alkoxyalkyl, carboxyalkyl, alkoxycarbonylalkyl or carbamoylalkyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 and R_{1a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group.

20 Another preferred aspect of the invention is a compound of formula I, wherein R_2 and R_{2a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group.

Another preferred aspect of the invention is a compound of formula I, wherein R_4 and R_{4a} taken together with the carbon atom through which they are linked form a 3 to 7 membered
25 cycloalkyl or cycloalkenyl group.

Another preferred aspect of the invention is a compound of formula I, wherein R_{1a} and R_{2a} are absent and R_1 and R_2 together with the carbon atoms through which R_1 and R_2 are linked form an aryl or heteroaryl group.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 and R_2
30 together with the carbon atoms through which R_1 and R_2 are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group, or heterocyclenyl group.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 and R_2 together with the carbon atoms through which R_1 and R_2 are linked form a cyclohexyl group.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 and R_2
35 together with the carbon atoms through which R_1 and R_2 are linked form a cyclohexenyl group.

Another preferred aspect of the invention is a compound of formula I, wherein L_1 is absent, optionally substituted alkylene, optionally substituted alkenylene, $-C(O)NR_5-$, $-S(O)p-$, $-C(O)-$, $-C(O)Y-C(X)Y-$, $-C(O)O-$, $C(O)NR_5-S(O)p-$, $-C(O)-C(O)NR_5S(O)p-$, $-S(O)pNR_5-$, $-C(O)-$ alkylene- $O-$, $-C(O)-$ alkenylene- $O-$, $-S(O)p$ -alkenylene-, $-S(O)p$ -alkylene-, $-C(O)-$ alkylene- $C(O)-$,
 5 $-C(O)-$ alkylene- $S(O)p-$, $-S(O)p$ -alkylene- $C(O)-$, $-C(O)-$ alkylene-, $-C(O)-$ alkenylene-, -alkylene- $C(O)NR_5-$, or $-C(O)CH(OH)-$ alkylene-.

Another preferred aspect of the invention is a compound of formula I, wherein L_1 is methylene, $-C(O)-$ alkylene- $O-$, $-C(O)-$ alkenylene-, $-S(O)p$ -alkenylene-, $-C(O)C(O)NR_5-$ or $-S(O)p-$.

10 Another preferred aspect of the invention is a compound of formula I, wherein Cy_1 is optionally substituted aryl, heteroaryl, optionally substituted heterocyclyl, optionally substituted heterocyclenyl, optionally substituted cycloalkyl, optionally substituted cycloalkenyl, optionally substituted fused arylcycloalkyl, optionally substituted fused arylcycloalkenyl, optionally substituted fused arylheterocyclyl, optionally substituted fused arylheterocyclenyl, optionally
 15 substituted fused heteroarylcyloalkyl, optionally substituted fused heteroarylcyloalkenyl, optionally substituted fused heteroarylheterocyclyl or optionally substituted fused heteroarylheterocyclenyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy_1 is optionally substituted aryl, heteroaryl, optionally substituted heterocyclyl, optionally substituted
 20 heterocyclenyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy_1 is optionally substituted with one of more groups selected from amino, halo, hydroxyl, aryl, heteroaryl, amidino, alkyl, acylamino, carbamoyl, cyano, alkoxy, nitro, carbamate, sulfamyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy_1 is
 25 optionally substituted with one of more groups selected from $-NH_2$, chloro, carbamate or aminosulfamyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy_1 optionally contains at least substituent selected from oxime and oxo when Cy_1 is cycloalkyl, cycloalkenyl, heterocyclyl, heterocyclenyl, fused arylcycloalkyl, fused arylcycloalkenyl, fused
 30 arylheterocyclyl, fused arylheterocyclenyl, fused heteroarylcyloalkyl fused heteroarylcyloalkenyl, fused heteroarylheterocyclyl or fused heteroarylheterocyclenyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 is alkyl, hydrogen or alkoxy-carbonyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 is
 35 alkoxy-carbonylalkyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 is alkyl, R_4 is alkyl, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene- or $-S(O)_2$ -alkylene- and Cy_1 is optionally substituted heteroaryl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene- or $-S(O)_2$ -alkylene-, and Cy_1 is optionally substituted aryl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene- or $-S(O)_2$ -alkylene-, and Cy_1 is optionally substituted heteroaryl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene- or $-S(O)_2$ -alkylene-, and Cy_1 is optionally substituted azaheteroaryl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1a} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene- or $-S(O)_2$ -alkylene-, and Cy_1 is optionally substituted thiaheteroaryl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1a} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene- or $-S(O)_2$ -alkylene-, and Cy_1 is optionally substituted benzothiophenyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1a} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, and Cy_1 is optionally substituted indolyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1a} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, and Cy_1 is optionally substituted benzimidazolyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1a} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, and Cy_1 is optionally substituted thienyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 is alkyl, R_4 is alkyl, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, L_2 is alkylene, Cy_1 is optionally substituted heteroaryl and Cy_2 is optionally substituted heteroaryl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1a} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, L_2 is alkylene, Cy_1 is optionally substituted heteroaryl, and Cy_2 is optionally substituted aryl, optionally substituted cycloalkyl, optionally substituted cycloalkenyl, optionally substituted heteroaryl, optionally substituted heterocyclyl or optionally substituted heterocyclenyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1b} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, L_2 is alkylene, Cy_1 is optionally substituted heteroaryl, and Cy_2 is optionally substituted heteroaryl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1b} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, L_2 is alkylene, Cy_1 is heteroaryl, and Cy_2 is optionally substituted azaindolyl, optionally substituted quinazolinyl or optionally substituted piperdinyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1b} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, L_2 is alkylene, Cy_1 is optionally substituted azaheteroaryl, and Cy_2 is optionally substituted azaheteroaryl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1b} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, L_2 is alkylene, Cy_1 is optionally substituted thiaheteroaryl, and Cy_2 is optionally substituted azaindolyl, optionally substituted quinazolinyl or optionally substituted piperdinyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1b} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, L_2 is alkylene, Cy_1 is optionally substituted benzothiophenyl, and Cy_2 is optionally substituted azaindolyl, optionally substituted quinazolinyl or optionally substituted piperdinyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1b} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, L_2 is alkylene, Cy_1 is optionally substituted indolyl, and Cy_2 is optionally substituted azaindolyl, optionally substituted quinazolinyl or optionally substituted piperdinyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1b} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, L_2 is alkylene, Cy_1 is optionally substituted benzimidazolyl, and Cy_2 is optionally substituted azaindolyl, optionally substituted quinazolinyl or optionally substituted piperdinyl.

Another preferred aspect of the invention is a compound of formula I, wherein R_1 , R_{1a} , R_{1b} , R_4 , and R_{4a} , are hydrogen, L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene or $-S(O)_2$ -alkylene, L_2 is alkylene, Cy_1 is optionally substituted thienyl, and Cy_2 is optionally substituted azaindolyl or optionally substituted quinazolinyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy_2 is quinazolinyl substituted by an amino substituent.

Another preferred aspect of the invention is a compound of formula I, wherein Cy_2 is quinazolinyl substituted by $-NH_2$ or $-N(alkyl)_2$.

Another preferred aspect of the invention is a compound of formula I, wherein R₂ is hydrogen, carboxyalkyl, alkoxyalkyl, hydroxyalkyl, alkoxycarbonylalkyl, acylamino or carbamoyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is piperdinyI.

5 Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is N-substituted piperdinyI.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is N-substituted piperdinyI and the piperdinyI moiety is attached to the parent moiety at the 4-position of the piperdinyI ring.

10 Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is a piperdinyI moiety substituted on the nitrogen ring atom by a group selected from aryl or heteroaryl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is a piperdinyI moiety substituted on the nitrogen ring atom by an azaheteroaryl group.

15 Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is a piperdinyI moiety substituted on the nitrogen ring atom by a group selected from 2-pyridyl, 4-pyridyl or 4-pyrimidyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is a piperdinyI moiety substituted on the nitrogen ring atom by an optionally substituted pyrimidyl group.

20 Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is a piperdinyI moiety substituted on the nitrogen ring atom by a pyrimidyl group wherein said pyrimidyl group is attached to the piperdinyI moiety at the 4-position of said pyrimidyl group.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is a piperdinyI moiety substituted on the nitrogen ring atom by a pyrimidyl group wherein said pyrimidyl group is substituted by an aryl group substituent, more preferably, said pyrimidyl group is substituted at its 2-position by a group selected from halogen, alkoxy, alkylthio and Y₁Y₂N-, wherein Y₁ and Y₂ are independently, hydrogen, alkyl or aralkyl.

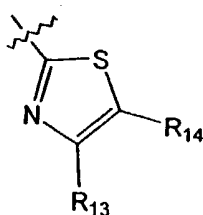
25 Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is optionally substituted thiazolyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is thiazolyl substituted by at least one substituent selected from lower alkyl, aryl, heteroaryl, amino, acylaminoalkyl, alkoxycarbonylalkyl, carbamoylalkyl and alkoxyalkyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy₂ is a group of formula

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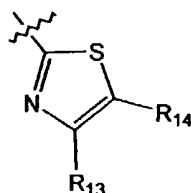
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wherein R_{13} and R_{14} are independently hydrogen, lower alkyl, aryl, heteroaryl, amino, acylaminoalkyl, alkoxycarbonylalkyl, carbamoylalkyl or alkoxyalkyl; or R_{13} and R_{14} together with the carbon atoms through which R_{13} and R_{14} are linked form a cycloalkyl group, cycloalkenyl

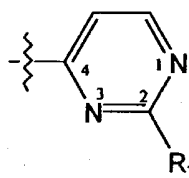
5 group, heterocyclyl group, heterocyclenyl group, aryl group or heteroaryl group.

Another preferred aspect of the invention is a compound of formula I, wherein Cy_2 is a group of formula



10 wherein R_{13} and R_{14} together with the carbon atoms through which R_{13} and R_{14} are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group or heterocyclenyl group, optionally substituted with an oxo moiety.

Another preferred aspect of the invention is a compound of formula I, wherein Cy_2 is a piperdinyll moiety substituted on the nitrogen ring atom by a pyrimidyl group of formula



15 R_{15} wherein R_{15} is selected from halogen, alkoxy, alkylthio and Y_1Y_2N- , wherein Y_1 and Y_2 are independently, hydrogen, alkyl and aralkyl.

Another preferred aspect of the invention is a compound of formula I, wherein Cy_2 is a piperdinyll moiety substituted on the nitrogen ring atom by a group selected from alkoxycarbonyl, carbamoyl, acyl, alkyl and amidino.

Another preferred aspect of the invention is a compound of formula I, wherein Cy_2 is a

20 piperdinyll moiety substituted on the nitrogen ring atom by $\text{---}\text{N}(\text{CN})\text{---NR}_{12}\text{R}_{12}'$ wherein R_{12} and R_{12}' are independently selected from hydrogen or optionally substituted lower alkyl.

Other preferred compounds have formula I wherein m is 1; and n is 1.

Other preferred compounds have formula I wherein A is N.

Other preferred compounds have formula I wherein R_3 and R_{3a} taken together are O; and R_1 , R_{1a} , R_2 , R_{2a} , R_4 and R_{4a} are hydrogen.

5

Other preferred compounds have formula I wherein R_3 and R_{3a} taken together are O; R_1 , R_{1a} , R_2 , R_{2a} and R_4 are hydrogen; and R_{4a} is optionally substituted alkyl.

Other preferred compounds have formula I wherein R_3 and R_{3a} taken together are O; R_1 , R_{1a} , R_2 and R_4 are hydrogen; and R_{2a} and R_{4a} are optionally substituted alkyl.

10

Other preferred compounds have formula I wherein R_3 and R_{3a} taken together are O; R_1 , R_2 , R_{2a} and R_4 are hydrogen; and R_{1a} and R_{4a} are optionally substituted alkyl.

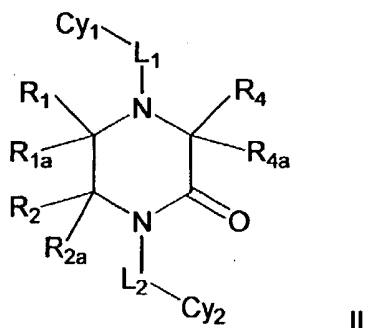
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Other preferred compounds have formula I wherein R_3 and R_{3a} taken together are O; R_1 , R_2 , R_{2a} , R_4 and R_{4a} are hydrogen; and R_{1a} is carboxy, alkoxycarbonyl, Y_1Y_2NCO or optionally substituted alkyl.

Other preferred compounds have formula I wherein R_3 and R_{3a} taken together are O; and R_1 , R_{1a} , R_2 , R_4 and R_{4a} are hydrogen; and R_{2a} is carboxy, alkoxycarbonyl, Y_1Y_2NCO or optionally substituted alkyl.

20

Another preferred aspect of the invention is directed to a compound of formula II



II

or a pharmaceutically acceptable salt thereof, pharmaceutically acceptable prodrug thereof, an N-oxide thereof, a hydrate thereof or a solvate thereof, wherein R_1 , R_{1a} , R_2 , R_{2a} , R_4 , R_{4a} , Cy_1 , Cy_2 , L_1 , and L_2 are as defined in formula I.

25

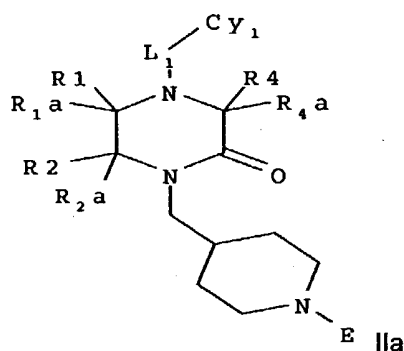
Preferred compounds have formula I or formula II wherein Cy_2 contains at least one nitrogen atom and when Cy_2 is optionally substituted aryl, optionally substituted cycloalkyl,

optionally substituted cycloalkenyl, optionally substituted fused phenylcycloalkyl or optionally substituted fused phenylcycloalkenyl, then said nitrogen atom is a basic nitrogen atom.

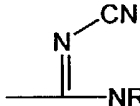
Another preferred aspect of the invention is a compound of formula I or formula II,
 5 wherein Z is absent or is selected from O, S(O)_p and NR₅.

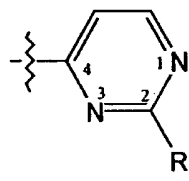
Another preferred aspect of the invention is a compound of formula I or formula II,
 wherein Z is -NR₅C(O)- or -C(O)NR₅-.

Another preferred aspect of the invention is a compound of formula IIa,



10 wherein R₁, R_{1a}, R₂, R_{2a}, R₃, R_{3a}, R₄, R_{4a}, Cy₁, and L₁, are as defined in formula I, E is

alkoxycarbonyl, carbamoyl, acyl, alkyl, pyridinyl, amidino;  NR₁₂R_{12'} wherein R₁₂ and R_{12'} are independently selected from hydrogen or optionally substituted lower alkyl; or



15 R₁₅ wherein R₁₅ is selected from halogen, alkoxy, alkylthio and Y₁Y₂N-, wherein Y₁ and Y₂ are independently, hydrogen, alkyl and aralkyl.

Another preferred aspect of the invention is a compound of formula I or formula II,
 wherein L₁ is -S(O)_p-, -C(X)Y- or -L₃-Q-L₄-Q'-L₅-.

20 Another preferred aspect of the invention is a compound of formula I or formula II,
 wherein Cy₁ is optionally substituted aryl or optionally substituted heteroaryl.

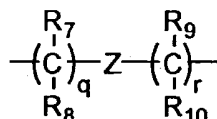
Another preferred aspect of the invention is a compound of formula I wherein R_1 , R_2 , R_3 and R_4 are independently alkyl, alkoxyalkyl, aminoalkyl, aminoalkylalkoxy, heterocyclyl, heterocyclenyl, heteroaryl, aryl, cycloalkyl, or cycloalkenyl or R_4 and R_{4a} taken together form O.

5 More preferred compounds are those having a structure of formula I or formula II, wherein L_2 is alkylene of one to three carbon atoms.

Other more preferred compounds are those having a structure of formula I or formula II, wherein L_2 is $-\text{CH}_2-$.

10

Other more preferred compounds are those having a structure of formula I or formula II, wherein L_2 is a group of formula



15 wherein Z is NR_5 ; q is 2; r is 0; R_5 is hydrogen or optionally substituted alkyl; and R_7 and R_8 are hydrogen.

Other more preferred compounds are those having a structure of formula I or formula II, wherein R_5 is hydrogen.

20 Other more preferred compounds are those having a structure of formula I or formula II, wherein Cy_2 is optionally substituted aryl or optionally substituted heteroaryl.

Other more preferred compounds are those having a structure of formula I or formula II, wherein L_1 is $-\text{S}(\text{O})_2-$.

25

Other more preferred compounds are those having a structure of formula I or formula II, wherein L_1 is $-\text{C}(\text{X})\text{Y}-$; X is O; and Y is NH.

30 Other more preferred compounds are those having a structure of formula I or formula II, wherein L_1 is $-\text{L}_3-\text{Q}-\text{L}_4-\text{Q}'-\text{L}_5-$; Q is $-\text{S}(\text{O})_2-$ or $-\text{C}(\text{O})-$; and L_4 is optionally substituted alkenylene.

Other more preferred compounds are those having a structure of formula I or formula II, wherein L_1 is $-\text{L}_3-\text{Q}-\text{L}_4-\text{Q}'-\text{L}_5-$; and L_4 is optionally substituted alkylene.

Other more preferred compounds are those having a structure of formula I or formula II, wherein L_1 is $-L_3-Q-L_4-Q'-L_5-$; Q is $-C(O)-$; Q' is O ; and L_4 is optionally substituted alkylene.

5 Other more preferred compounds are those having a structure of formula I or formula II, wherein L_1 is methylene, $-L_3-Q-L_4-Q'-L_5-$; L_3 is optionally substituted alkylene; and L_4 is optionally substituted alkenylene.

10 Other more preferred compounds are those having a structure of formula I or formula II, wherein Cy_1 is optionally substituted phenyl, optionally substituted thienyl, optionally substituted benzothienyl, optionally substituted isoquinoliny, optionally substituted indolyl, optionally substituted thienopyridyl, optionally substituted furanyl, optionally substituted pyridyl, or optionally substituted benzimidazolyl.

15 Other more preferred compounds are those having a structure of formula I or formula II, wherein Cy_2 is optionally substituted phenyl, optionally substituted pyridyl, optionally substituted imidazolyl, optionally substituted quinoliny, optionally substituted isoquinoliny, optionally substituted quinazoliny, optionally substituted cinnoliny, optionally substituted azaindolyl, or optionally substituted thienopyridyl.

20 Other more preferred compounds are those having a structure of formula I wherein A is N ;

G_1 is L_1-Cy_1 and G_2 is L_2-Cy_2 ;

L_1 and L_2 are independently absent, methylene, ethylene, sulfonyl, alkylenesulfonyl or alkylene;

25 Cy_1 is thiaheteroaryl, thiaheterocyclyl, thiaheterocyclenyl, fused thiaheteroarylcyloalkyl, fused thiaheteroarylcyloalkenyl, fused heteroarylthiacycloalkyl or fused heteroarylthiacycloalkenyl, thiophen-isoxazolyl, thieno-pyridineyl, benzo-thiophen, indolyl, morpholiny, aminopyridine-benzyl, pyrimidin-benzyl, aminoquinazolin, pyrimidin-piperidin, thiophen-pyrazol, thiophen-oxadiazol, thiophen-thiadiazol, thiophen-triazol, thiophen-pyridin, phenyl-triazol optionally
30 substituted aryl, optionally substituted heteroaryl, optionally substituted cycloalkyl, optionally substituted cycloalkenyl, optionally substituted heterocyclyl, optionally substituted heterocyclenyl, optionally substituted fused arylcyloalkyl, optionally substituted fused arylcyloalkenyl, optionally substituted fused arylheterocyclyl, optionally substituted fused arylheterocyclenyl, optionally substituted fused heteroarylcyloalkyl, optionally substituted fused

heteroarylcycloalkenyl, optionally substituted fused heteroarylheterocyclyl or optionally substituted fused heteroarylheterocyclenyl;

Cy₂ is amino-quinazolin, benzhydrylidene-amino, pyrrolo-pyridin, bipyridinyl, pyridin-benzyl, thiophenyl, thiophen-benzyl, optionally substituted aryl, optionally substituted heteroaryl,

- 5 optionally substituted cycloalkyl, optionally substituted cycloalkenyl, optionally substituted heterocyclyl, optionally substituted heterocyclenyl, optionally substituted fused arylcycloalkyl, optionally substituted fused arylcycloalkenyl, optionally substituted fused arylheterocyclyl, optionally substituted fused arylheterocyclenyl, optionally substituted fused heteroarylcycloalkyl, optionally substituted fused heteroarylcycloalkenyl, optionally substituted fused heteroarylheterocyclyl, optionally substituted fused heteroarylheterocyclenyl, azaheteroaryl, azaheterocyclyl, azaheterocyclenyl, fused azaheteroarylcycloalkyl, fused azaheteroarylcycloalkenyl, fused heteroarylazacycloalkyl or fused heteroarylazacycloalkenyl;

R₃ and R_{3a} taken together form O or S;

- R₂ and R_{2a} are independently selected from hydrogen, alkyl, aminoalkyl, alkylaminoalkyl, alkoxy, 15 alkoxyalkyl, alkoxyaminoalkyl, cycloalkylalkylamino, benzyloxyalkyl, isopropyl, aminomethyl, methoxyethylaminomethyl, piperazin, pyrrolidin, ethoxymethyl, benzyloxymethyl, methoxymethyl, isobutyl, isopropylamino or isopropylaminomethyl, provided that R₂ and R_{2a} are not each hydrogen, or carboxy, alkoxycarbonyl, Y₁Y₂NC(O)-, wherein Y₁ and Y₂ are defined as in formula I, optionally substituted alkyl, optionally substituted aryl, optionally substituted aralkyl, 20 optionally substituted heteroaryl and optionally substituted heteroaralkyl; or R₁ and R₂ together with the carbon atoms through which R₁ and R₂ are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group, or heterocyclenyl group; or R_{1a} and R_{2a} are absent and R₁ and R₂ together with the carbon atoms through which R₁ and R₂ are linked form an aryl or heteroaryl group; or R₂ and R_{2a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group;

R₁ and R_{1a} are independently selected from hydrogen, carboxy, alkoxycarbonyl, Y₁Y₂NC(O)-, wherein Y₁ and Y₂ are defined as in formula I, optionally substituted alkyl, optionally substituted aryl, optionally substituted aralkyl, optionally substituted heteroaryl and optionally substituted heteroaralkyl;

- 30 or R₁ and R_{1a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group;

R₄ and R_{4a} are independently selected from hydrogen, carboxy, alkoxycarbonyl, Y₁Y₂NC(O)-, wherein Y₁ and Y₂ are defined as in formula I, optionally substituted alkyl, optionally substituted aryl, optionally substituted aralkyl, optionally substituted heteroaryl and optionally substituted

- 35 heteroaralkyl or R₄ and R_{4a} taken together with the carbon atom through which they are linked

form a 3 to 7 membered cycloalkyl or cycloalkenyl group, or R_4 and R_{4a} taken together form O or S; and m and n are each 1.

Other more preferred compounds are those having a structure of formula I wherein A is

5 N;

G_1 is L_1-Cy_1 and G_2 is L_2-Cy_2 ;

L_1 is sulfonyl or alkylsulfonyl;

L_2 is absent, methylene, ethylene or alkylene;

Cy_1 is thiaheteroaryl, thiaheterocyclyl, thiaheterocyclenyl, fused thiaheteroarylcyloalkyl, fused

10 thiaheteroarylcyloalkenyl, fused heteroarylthiacycloalkyl or fused heteroarylthiacycloalkenyl,

thiophen-isoxazolyl, thieno-pyridinyl, benzo-thiophen, indolyl, morpholinyl, optionally substituted

aryl, optionally substituted heteroaryl, optionally substituted cycloalkyl, optionally substituted

cycloalkenyl, optionally substituted heterocyclyl, optionally substituted heterocyclenyl, optionally

substituted fused arylcyloalkyl, optionally substituted fused arylcyloalkenyl, optionally

15 substituted fused arylheterocyclyl, optionally substituted fused arylheterocyclenyl, optionally

substituted fused heteroarylcyloalkyl, optionally substituted fused heteroarylcyloalkenyl,

optionally substituted fused heteroarylheterocyclyl or optionally substituted fused

heteroarylheterocyclenyl;

Cy_2 is amino-quinazolin, benzhydrylidene-amino, pyrrolo-pyridin, optionally substituted aryl,

20 optionally substituted heteroaryl, optionally substituted cycloalkyl, optionally substituted

cycloalkenyl, optionally substituted heterocyclyl, optionally substituted heterocyclenyl, optionally

substituted fused arylcyloalkyl, optionally substituted fused arylcyloalkenyl, optionally

substituted fused arylheterocyclyl, optionally substituted fused arylheterocyclenyl, optionally

substituted fused heteroarylcyloalkyl, optionally substituted fused heteroarylcyloalkenyl,

25 optionally substituted fused heteroarylheterocyclyl, optionally substituted fused

heteroarylheterocyclenyl, azaheteroaryl, azaheterocyclyl, azaheterocyclenyl, fused

azaheteroarylcyloalkyl, fused azaheteroarylcyloalkenyl, fused heteroarylazacyloalkyl or

fused heteroarylazacyloalkenyl;

R_3 and R_{3a} taken together form O or S;

30 R_2 and R_{2a} are independently selected from hydrogen, alkyl, aminoalkyl, alkylaminoalkyl, alkoxy,

alkoxyalkyl, alkoxyaminoalkyl, cycloalkylalkylamino, benzyloxyalkyl, isopropyl, aminomethyl,

methoxyethylaminomethyl, piperazin, pyrrolidin, ethoxymethyl, benzyloxymethyl,

methoxymethyl, isobutyl, isopropylamino or isopropylaminomethyl, provided that R_2 and R_{2a} are

not each hydrogen;

R_1 , R_{1a} , R_4 and R_{4a} are independently selected from hydrogen, carboxy, alkoxycarbonyl, $Y_1Y_2NC(O)-$, wherein Y_1 and Y_2 are defined as in claim 1, optionally substituted alkyl, optionally substituted aryl, optionally substituted aralkyl, optionally substituted heteroaryl and optionally substituted heteroaralkyl;

or the pairs R_1 and R_{1a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; or R_4 and R_{4a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group;

and m and n are each 1.

Other more preferred compounds are those having a structure of formula I wherein A is N;

G_1 is L_1-Cy_1 and G_2 is L_2-Cy_2 ;

L_1 and L_2 are independently absent, methylene, ethylene or alkylene;

Cy_1 is thiophen-isoxazolyl, aminopyridine-benzyl, benzo-thiophen, pyrimidin-benzyl, aminoquinazolin, pyrimidin-piperidin, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted cycloalkyl, optionally substituted cycloalkenyl, optionally substituted heterocyclyl, optionally substituted heterocyclenyl, optionally substituted fused arylcycloalkyl, optionally substituted fused arylcycloalkenyl, optionally substituted fused arylheterocyclyl, optionally substituted fused arylheterocyclenyl, optionally substituted fused heteroarylcyaloalkyl, optionally substituted fused heteroarylcyaloalkenyl, optionally substituted fused heteroarylheterocyclyl or optionally substituted fused heteroarylheterocyclenyl;

Cy_2 is bipyridinyl, amino-quinazolin, pyridin-benzyl, thiophenyl, thiophen-benzyl, pyrrolo-pyridin, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted cycloalkyl, optionally substituted cycloalkenyl, optionally substituted heterocyclyl, optionally substituted heterocyclenyl, optionally substituted fused arylcycloalkyl, optionally substituted fused arylcycloalkenyl, optionally substituted fused arylheterocyclyl, optionally substituted fused arylheterocyclenyl, optionally substituted fused heteroarylcyaloalkyl, optionally substituted fused heteroarylcyaloalkenyl, optionally substituted fused heteroarylheterocyclyl or optionally substituted fused heteroarylheterocyclenyl;

R_3 and R_{3a} taken together form O or S; and

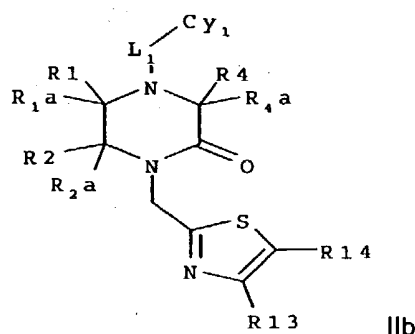
R_4 and R_{4a} taken together form O or S;

R_1 , R_{1a} , R_2 , R_{2a} , are independently selected from hydrogen, carboxy, alkoxycarbonyl,

$Y_1Y_2NC(O)-$, wherein Y_1 and Y_2 are defined as in claim 1, optionally substituted alkyl, optionally substituted aryl, optionally substituted aralkyl, optionally substituted heteroaryl and optionally

- substituted heteroaralkyl; or R_1 and R_2 together with the carbon atoms through which R_1 and R_2 are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group, or heterocyclenyl group; or R_{1a} and R_{2a} are absent and R_1 and R_2 together with the carbon atoms through which R_1 and R_2 are linked form an aryl or heteroaryl group; or one or more of the pairs R_1 and R_{1a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; or R_2 and R_{2a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; and m and n are each 1.
- 10 Other more preferred compounds are those having a structure of formula I wherein A is N; G_1 is L_1-Cy_1 and G_2 is L_2-Cy_2 ; L_1 and L_2 are independently absent, methylene, ethylene or alkylene; Cy_1 is thiophen-isoxazol, thiophen-pyrazol, thiophen-oxadiazol, thiophen-thiadiazol, thiophen-triazol, thiophen-pyridin or phenyl-triazol;
- 15 Cy_2 is amino-quinazolin or pyrrolo-pyridin; R_3 and R_{3a} taken together form O or S; R_1 , R_{1a} , R_2 , R_{2a} , R_4 and R_{4a} are independently selected from hydrogen, carboxy, alkoxycarbonyl, $Y_1Y_2NC(O)-$, wherein Y_1 and Y_2 are defined as in claim 1, optionally substituted alkyl, optionally substituted aryl, optionally substituted aralkyl, optionally substituted heteroaryl and optionally substituted heteroaralkyl; or R_1 and R_2 together with the carbon atoms through which R_1 and R_2 are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group, or heterocyclenyl group; or R_{1a} and R_{2a} are absent and R_1 and R_2 together with the carbon atoms through which R_1 and R_2 are linked form an aryl or heteroaryl group; or one or more of the pairs R_1 and R_{1a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; or R_2 and R_{2a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; or R_4 and R_{4a} taken together with the carbon atom through which they are linked form a 3 to 7 membered cycloalkyl or cycloalkenyl group; and m and n are each 1.

30 Another preferred aspect of the invention is a compound of formula IIb



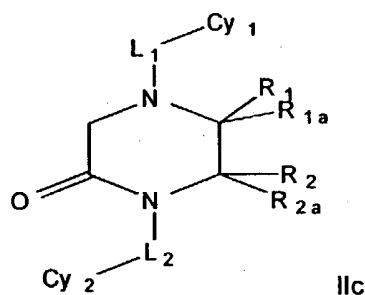
or a pharmaceutically acceptable salt thereof, pharmaceutically acceptable prodrug thereof, an N-oxide thereof, a hydrate thereof or a solvate thereof,

wherein L_1 , Cy_1 , R_1 , R_{1a} , R_2 , R_{2a} , R_4 and R_{4a} are as described in compound of formula I,

- 5 R_{13} and R_{14} are independently hydrogen, lower alkyl, aryl, heteroaryl, amino, acylaminoalkyl, alkoxyalkyl, carbamoylalkyl or alkoxyalkyl; or R_{13} and R_{14} together with the carbon atoms through which R_{13} and R_{14} are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group, heterocyclenyl group, aryl group or heteroaryl group.

- Another preferred aspect of the invention is a compound of formula IIb wherein R_{13} and R_{14} together with the carbon atoms through which R_{13} and R_{14} are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group or heterocyclenyl group, optionally substituted with an oxo moiety.

Other preferred compounds are those which inhibit both Factor Xa and Factor IIa (thrombin) activity, having a structure of formula IIc



or a pharmaceutically acceptable salt thereof, pharmaceutically acceptable prodrug thereof, an N-oxide thereof, a hydrate thereof or a solvate thereof, wherein:

Cy_1 is thiaheteroaryl, benzothiophenyl or azaheteroaryl, which are unsubstituted or substituted by halogen,

- 15 L_1 is $-S(O)_2-$, $-S(O)_2$ -alkylene-, $-S(O)_2$ -alkenylene- or $-S(O)_2$ -alkynylene-;

R_1 , R_{1a} , R_2 , R_{2a} are independently hydrogen, alkyl, alkoxyalkyl, aminoalkyl, aminoalkylalkoxy, carboxyl, alkoxyalkyl, or carbamoyl; L_2 is methylene; and

Cy₂ is azaheteroaryl, azaheterocyclyl, azaheterocyclenyl, fused azaheteroarylcyaloalkyl, fused azaheteroarylcyaloalkenyl, fused heteroarylazacycloalkyl or fused heteroarylazacycloalkenyl.

Other preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein:

Cy₁ is thiaheteroaryl or azaheteroaryl,

L₁ is -S(O)₂-, -S(O)₂-alkylene-, -S(O)₂-alkenylene- or -S(O)₂-alkynylene-;

R₁, R_{1a}, R₂, R_{2a} are independently hydrogen, alkoxyalkyl, hydroxyalkyl, aminoalkyl, alkylaminoalkyl, carboxyl, alkoxycarbonyl, or carbamoyl;

L₂ is methylene; and

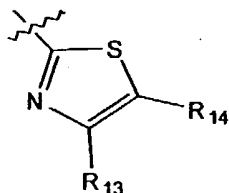
Cy₂ is azaheteroaryl, azaheterocyclyl, azaheterocyclenyl, fused azaheteroarylcyaloalkyl, fused azaheteroarylcyaloalkenyl, fused heteroarylazacycloalkyl or fused heteroarylazacycloalkenyl.

Other preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein Cy₂ is optionally substituted azaindolyl, optionally substituted quinazolinyl or optionally substituted piperdinyl.

Other preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein R₁, R_{1a}, R₂, and R_{2a} are independently aryl, heteroaryl, cycloalkyl, cycloalkenyl, heterocyclyl or heterocyclenyl.

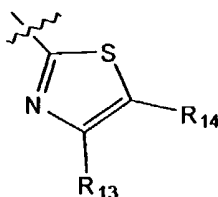
Other preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein Cy₂ is an optionally substituted thiazolyl.

Other preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein Cy₂ is a group of formula



wherein R₁₃ and R₁₄ are independently hydrogen, lower alkyl, aryl, heteroaryl, amino, acylaminoalkyl, alkoxycarbonylalkyl, carbamoylalkyl or alkoxyalkyl; or R₁₃ and R₁₄ together with the carbon atoms through which R₁₃ and R₁₄ are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group, heterocyclenyl group, aryl group or heteroaryl group.

Other preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein Cy₂ is a group of formula



wherein R_{13} and R_{14} together with the carbon atoms through which R_{13} and R_{14} are linked form a cycloalkyl group, cycloalkenyl group, heterocyclyl group or heterocyclenyl group, optionally substituted with an oxo or oxime substituent.

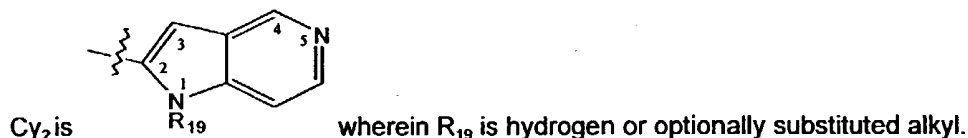
5 Other preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein Cy_2 is optionally substituted azaindolyl.

More preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein Cy_2 is optionally substituted 5-
10 azaindolyl.

More preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein,

when Cy_2 is optionally substituted azaindolyl, the parent molecule is attached to the azaindolyl group at the 2-position.

15 More preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein



More preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein

20 Cy_2 is optionally substituted azaindolyl;

L_1 is $-S(O)_2-$, $-S(O)_2$ -alkenylene;

Cy_1 is optionally substituted thienyl or optionally substituted benzothiophenyl,

R_1 and R_2 are hydrogen;

R_{1a} and R_{2a} are independently hydrogen, alkyl, carboxyl, alkoxy carbonyl, or carbamoyl.

25 More preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein

R_1 , R_{1a} and R_2 are hydrogen; and

R_{2a} is alkyl, carboxyl, alkoxy carbonyl, or carbamoyl.

More preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein

Cy₂ is optionally substituted azaindolyl;

L₁ is -S(O)₂-, or -S(O)₂-alkenylene;

5 Cy₁ is optionally substituted thienyl or optionally substituted benzothiophenyl, optionally substituted, optionally substituted benzimidazolyl, or optionally substituted indolyl,

R₁, R_{1a} and R₂ are hydrogen; and

R_{2a} is alkyl, carboxyl, alkoxycarbonyl, or carbamoyl.

More preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein

R₁, R₂ and R_{2a} are hydrogen; and

R_{1a} is alkyl, carboxyl, alkoxycarbonyl, or carbamoyl.

More preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula IIc wherein

15 Cy₂ is optionally substituted azaindolyl;

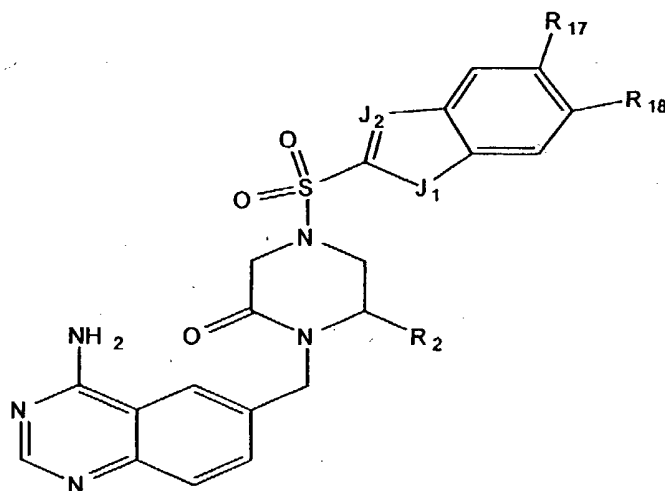
L₁ is -S(O)₂-, or -S(O)₂-alkenylene;

Cy₁ is optionally substituted thienyl or optionally substituted benzothiophenyl,

R_{1a} is alkyl, carboxyl, alkoxycarbonyl, or carbamoyl; and

R₁, R₂ and R_{2a} are hydrogen.

20 Other preferred compounds which inhibit both Factor Xa and Factor IIa (thrombin) activity are those having a structure of formula II d



II d

wherein R₁₇ and R₁₈ are independently hydrogen or halogen;

J₁ is S or NH;

25 J₂ is CH or N; and

R₂ is hydrogen, alkyl, carboxyl, alkoxycarbonyl, or carbamoyl.

Another preferred aspect of the invention is a compound of formula IId wherein R₂ is heterocyclalkyloxycarbonyl, heterocyclenylalkyloxycarbonyl, heteroaralkyloxycarbonyl, arylalkyloxycarbonyl, cycloalkylalkyloxycarbonyl, or cycloalkenylalkyloxycarbonyl.

5 Another preferred aspect of the invention is a compound of formula IId wherein R₂ is heterocyclalkylcarbamoyl, heterocyclenylalkylcarbamoyl, heteroaralkylcarbamoyl, arylalkylcarbamoyl, cycloalkylcarbamoyl, or cycloalkenylcarbamoyl.

Another preferred aspect of the invention is a compound of formula IId wherein R₂ is heterocycl, heterocyclenyl, heteroaryl, aryl, cycloalkyl, or cycloalkenyl.

10 Another preferred aspect of the invention is a compound of formula IId wherein R₂ is heterocyclalkyloxycarbonylalkyl, heterocyclenylalkyloxycarbonylalkyl, heteroaralkyloxycarbonylalkyl, arylalkyloxycarbonylalkyl, cycloalkylalkyloxycarbonylalkyl, or cycloalkenylalkyloxycarbonylalkyl.

Another preferred aspect of the invention is a compound of formula IId wherein R₂ is
15 heterocyclalkylcarbamoylalkyl, heterocyclenylalkylcarbamoylalkyl, heteroaralkylcarbamoylalkyl, arylalkylcarbamoylalkyl, cycloalkylcarbamoylalkyl, or cycloalkenylcarbamoylalkyl.

Another preferred aspect of the invention is a compound of formula IId wherein R₂ is alkoxyalkyl, hydroxyalkyl or aminoalkyl.

20 Another preferred aspect of the invention is a compound of formula IId wherein R₂ is alkyl(H)N-alkyl-.

Compounds contemplated as falling within the scope of this invention, include, but are not limited to

25

Preferred compounds wherein Z is -NR₅C(O)- or -C(O)NR₅- are selected from

or a pharmaceutically acceptable salt thereof, pharmaceutically acceptable prodrug thereof, an N-oxide thereof, a hydrate thereof or a solvate thereof.

30

Preferred intermediates according to this invention have formula III wherein Cy₂ contains at least one nitrogen atom and when Cy₂ is optionally substituted aryl, optionally substituted cycloalkyl, optionally substituted cycloalkenyl, optionally substituted fused phenylcycloalkyl or optionally substituted fused phenylcycloalkenyl, then said nitrogen atom is a basic nitrogen
35 atom.

Other preferred intermediates according to this invention have formula III wherein Z is absent.

5 Other preferred intermediates according to this invention have formula III wherein R₁, R_{1a}, R₂, R_{2a}, R₄ and R_{4a} are hydrogen.

Other preferred intermediates according to this invention have formula II, wherein L₁ and L₂ independently are methylene, ethylene, propylene or butenylene; R₁, R_{1a}, R₂, R_{2a} are
10 independently hydrogen, alkyl, alkoxyalkyl, aminoalkyl, aminoalkylalkoxy, carboxyl, alkoxy carbonyl, or carbamoyl; Cy₁ is heteroaryl, thiaheteroaryl, biheteroaryl, thiophenyl, isoxazolyl, isoxazolyl-thiophenyl or azaheteroaryl, which are unsubstituted or substituted by halogen; Cy₂ is azaheteroaryl, quinazolin, amino-quinazolin or 4-aminoquinazolin.

15 More preferred intermediates according to this invention are selected from
(2S, 6RS)-4-(4-chloro-quinolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester,
(3S,5RS)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one,
(3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one,
20 (3S, 5S)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one,
(3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one,
(2S, 6R)-4-(4-chloro-quinolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester,
(3S, 5S)-1-(4-chloro-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-
25 piperazine-2-one,
(3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-piperazine-2-one,
4-(2-Oxopiperazin-1-ylmethyl)benzamidine,
1-(2-Aminoquinolin-6-ylmethyl)piperazin-2-one,
30 1-(1-Aminoisoquinolin-6-ylmethyl)piperazin-2-one,
2-(2-Oxopiperazin-1-ylmethyl)pyrrolo[3,2-c]pyridin-1-carboxylic acid tert-butyl ester,
2-(5-(±)-Methoxycarbonyl-2-oxo-piperazin-1-ylmethyl)-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester,
2-(2-(±)-Methoxycarbonyl-6-oxo-piperazin-1-ylmethyl)-pyrrolo[3,2-c]pyridine-1-carboxylic acid
35 tert-butyl ester,

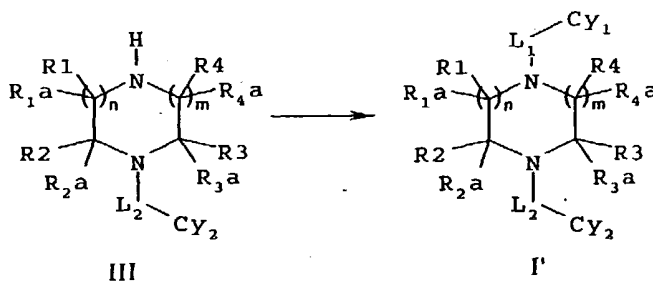
- 1-(4-Aminoquinazoline-7-ylmethyl)piperazine-2-one,
1-(4-Amino-thieno[2,3-d]pyrimidin-6-ylmethyl)-piperazin-2-one,
4-[3-(2-Oxo-piperazin-1-yl)-propyl]-piperidine-1-carboxylic acid tert-butyl ester,
1-(4-Amino-quinazoline-7-ylmethyl)-3-methoxymethyl-piperazine-2-one,
5 1-(4-Aminoquinazoline-7-ylmethyl)-3-butyl-piperazine-2-one,
1-(4-Aminoquinazoline-7-ylmethyl)-3-ethyl-piperazine-2-one,
1-(4-Aminoquinazoline-7-ylmethyl)-3-propyl-piperazine-2-one,
1-(4-Amino-quinazoline-7-ylmethyl)-3-ethoxymethyl-piperazine-2-one,
1-(4-Amino-quinazoline-7-ylmethyl)-3-methyl-piperazine-2-one,
10 1-(4-Amino-quinazoline-7-ylmethyl)-3-benzyl-piperazine-2-one,
1-(4-Amino-quinazoline-7-ylmethyl)-3-(1-methoxyethyl)-piperazine-2-one,
1-(4-Amino-quinazoline-7-ylmethyl)-3,3-dimethyl-piperazine-2-one,
1-(4-Amino-quinazoline-7-ylmethyl)-3-isopropyl-piperazine-2-one,
1-(4-Amino-quinazoline-7-ylmethyl)-3-isobutyl-piperazine-2-one,
15 1-(4-Amino-quinazoline-7-ylmethyl)-3-(2-methoxyethyl) l-piperazine-2-one,
1-(4-Amino-quinazoline-7-ylmethyl)-3-methoxymethyl-6-methyl-piperazine-2-one,
(3S,5RS)-1-(4-amino-quinazolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one,
1-(4-Chloroquinolin-7-ylmethyl)-piperazin-2-one,
1-(4-Chlorocinnolin-7-ylmethyl)-piperazin-2-one,
20 1-(4-Chloroquinolin-7-ylmethyl)-3-(S)-methylpiperazin-2-one,
1-[2-(Pyridin-4-ylamino)-ethyl]-piperazin-2-one,
1-[2-((Methyl)-(pyridin-4-yl)-amino)-ethyl]-piperazin-2-one trifluoroacetate,
1-[2-(3-Methylpyridin-4-yl-amino)-ethyl]-piperazin-2-one,
1-[2-(Pyridazin-4-ylamino)-ethyl]-piperazin-2-one,
25 4-[3-(4-tert-Butoxycarbonylamino-pyridin-3-yl)-propenyl]-3-oxo-piperazine-1-carboxylic acid
tert-butyl ester,
4-[3-(4-tert-butoxycarbonylamino-pyridin-3-yl)-allyl]-3-oxo-piperazine-1-carboxylic acid tert-butyl
ester
4-[3-(4-tert-Butoxycarbonylamino-pyridin-3-yl)-propyl]-3-oxo-piperazine-1-carboxylic acid tert-
30 butyl ester.
4-(Benzyloxycarbonyl)-1-(2-pyrrolo[3,2-c]pyridin-1-ylethyl)-piperazin-2-one,
(±)-1-(3-Amino-4-cyano-benzyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-
carboxylic acid methyl ester and
(±)-1-(3-Amino-4-cyano-benzyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-
35 carboxylic acid.

Preparation of the Compounds of the Invention

A general route to the compounds of this invention wherein A is N and R_1 , R_{1a} , R_2 , R_{2a} , R_3 , R_{3a} , R_4 , R_{4a} , L_1 , L_2 , Cy_1 , Cy_2 , m and n are defined for Formula I above is outlined in Scheme

5 1.

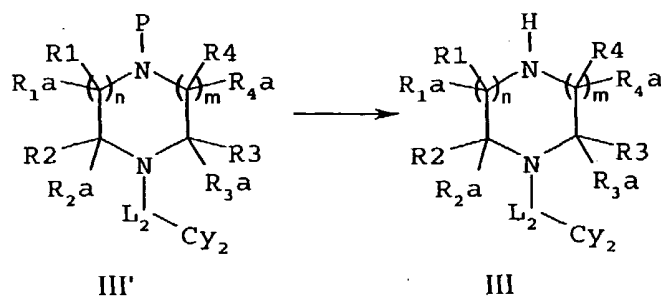
Scheme 1



As outlined in Scheme 1, coupling of a compound of formula III with a sulfonyl chloride, an alkyl halide, an acid or an activated derivative thereof, such as an acid anhydride or acid chloride, an isocyanate, chloroformate or activated sulfamoyl ester in an appropriate solvent, generates the compound of formula I in which the L_1 - Cy_1 portion is a sulfonamide, alkyl amine, amide, urea, carbamate or sulfamyl urea, respectively. Sulfonamide formation is accomplished with a base such as a trialkylamine in an inert solvent such as dichloromethane, THF or acetonitrile at about 0 °C to about 100 °C in the presence or absence of an activating agent such as dimethylaminopyridine (DMAP). Alkyl amine formation can be achieved with a suitable base such as K_2CO_3 or trialkylamine in an appropriate solvent such as DMF or acetonitrile at about 0 °C to about 100 °C. Amide, urea, carbamate and sulfamyl urea formation can be conducted with acids and coupling reagents such as EDC or TBTU or with any variant of reactive acid derivatives and the use of an appropriate base additive such as triethylamine, N-methylmorpholine or diisopropylethylamine.

The preparation of a compound of formula III wherein R_1 , R_{1a} , R_2 , R_{2a} , R_3 , R_{3a} , R_4 , R_{4a} , L_2 , Cy_2 , m and n are as defined herein from formula 1, is outlined in Scheme 2.

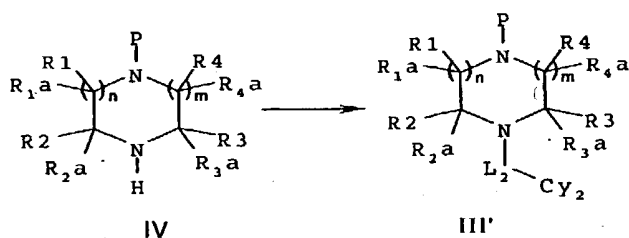
Scheme 2



As outlined in Scheme 2, a compound of formula III is prepared by removing a nitrogen protecting group P from the compound of formula III'. In a preferred aspect, P is an alkyl, aralkyl or aryl carbamate moiety, which is removed using strong acid, strong base or catalytic hydrogenation in an appropriate solvent such as methanol or ethanol.

The preparation of a compound of formula III' wherein R_1 , R_{1a} , R_2 , R_{2a} , R_3 , R_{3a} , R_4 , R_{4a} , L_1 , L_2 , Cy_1 , Cy_2 , m and n and P are defined herein is outlined in Scheme 3.

Scheme 3

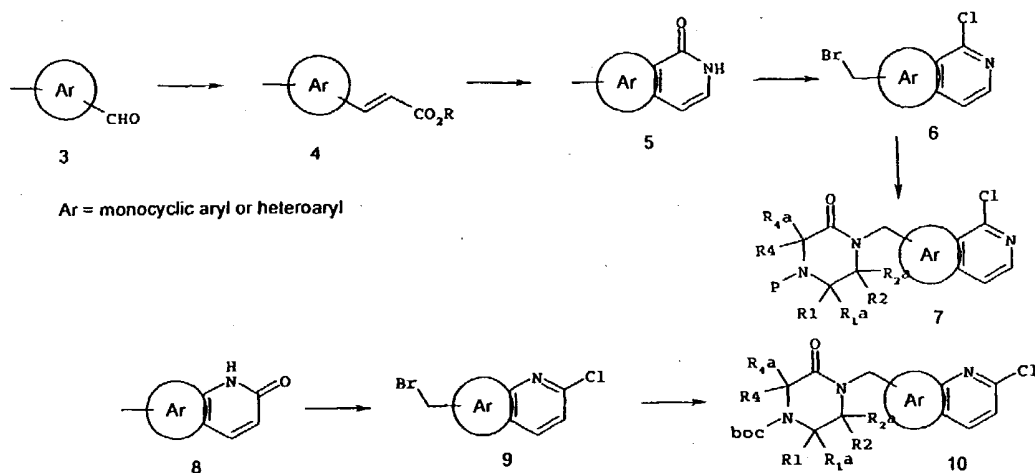


As indicated in Scheme 3, the compound of formula III' is obtained by coupling a compound of formula IV with an appropriate Cy_2-L_2-LG compound wherein LG is a leaving group, such as chloro, bromo, iodo, or optionally substituted lower alkylsulfonyloxy or arylsulfonyloxy, in an inert organic solvent, such as THF, Et_2O or DMF, in the presence of a strong base such as NaH, lithium hexamethyldisilylazide or lithium diisopropylamine. In a preferred aspect, P is an alkyl, aralkyl or aryl carbamate group.

The preparation of intermediate compounds of formula 7 and 10 is outlined in Scheme

4.

Scheme 4



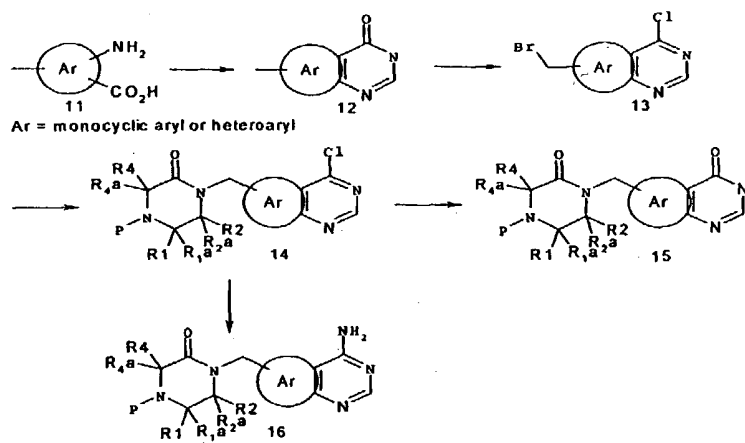
As indicated in Scheme 4, reacting a compound of formula 3 with an appropriate malonic acid in a polar , such as pyridine or ethanol, and a base, such as piperidine or pyridine, at reflux provides a compound of formula 4 wherein R is H. Alternatively, a compound of formula 3 may be reacted with a suitable Wittig or Horner-Emmons reagent in an inert solvent such as THF to give a compound of formula 4 wherein R is lower alkyl. When R is lower alkyl, the ester is hydrolyzed to the corresponding carboxylic acid (R is H) using an appropriate strong acid or alkali base. The corresponding acid is converted to the acid chloride using standard reagents such as thionyl chloride, or is converted to the mixed anhydride in a polar solvent, such as acetone or THF, to form an activated acyl compound. The activated acyl compound is then treated with a solution of NaN_3 in water at about -10°C to about 25°C to yield the corresponding acyl azide. The acyl azide compound is then heated slowly in an inert solvent such as benzene or toluene at about 60°C to about 110°C and then concentrated in vacuo and heated in a higher boiling inert solvent, such as 1,2-dichlorobenzene or phenyl ether, at about 180°C to about 240°C with a catalyst such as iodine or tributylamine to obtain a compound of formula 5. Alternatively the acyl azide compound can be added directly to a high boiling inert solvent, such as phenyl ether, at about 180°C to about 240°C with a catalyst such as iodine or tributylamine to obtain the compound of formula 5.

A compound of formula 8, prepared as described in Syn., 739 (1975), the contents of which are hereby incorporated herein by reference, or a compound of formula 5 above, may be chlorinated using standard reagents such as POCl_3 or $\text{POCl}_3/\text{PCl}_5$ and halogenated using standard conditions, such as N-halosuccinimide and benzoyl peroxide in an inert solvent such as carbon tetrachloride, to give the corresponding chloro-halomethyl compounds 6 and 9, respectively. Compounds of formula 6 or 9 are coupled to compounds of formula IV, in which

R3 and R3a taken together form oxo, under basic condition employing NaH, or KOtBu or some other deprotonating base, to give compounds of formula 7 or 10.

The preparation of aminoquinazoline, quinazolinone or amino-thienopyrimidine intermediates is outlined in Scheme 5.

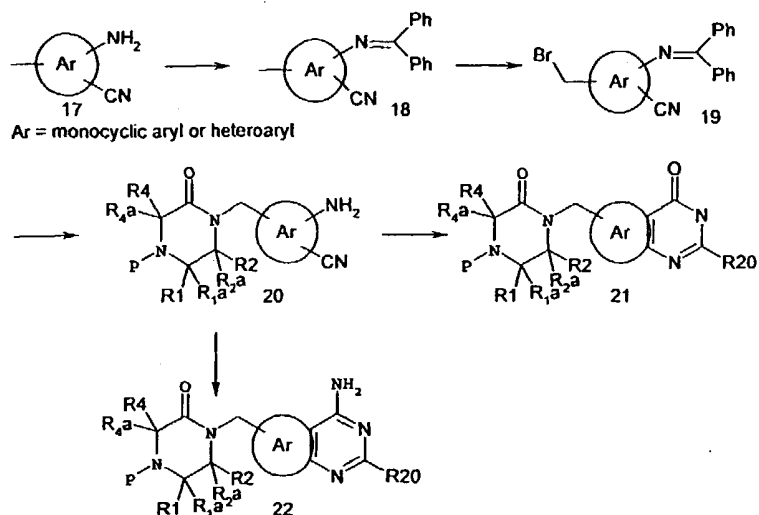
5 Scheme 5



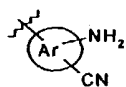
- As shown in Scheme 5, an aminoheteroaryl carboxylic acid or an aminoarylcarboxylic acid of formula 11, in which the amino and carboxylic acid are ortho to each other, is treated with formamidine under heat to form the corresponding quinazolinone or thienopyrimidinone 12.
- 10 The quinazolinone or thienopyrimidinone 12 is then converted to the chloroquinazoline or chlorothienopyrimidine using a chlorinating reagent such as $P(O)Cl_3$ and heat. The chloroquinazoline or chlorothienopyrimidine is brominated at the benzylic carbon using radical bromination conditions. Alternatively, a chloroquinazoline or chlorothienopyrimidine, containing a hydroxy-methylene group is converted to the corresponding bromide using CBR_4/PPh_3 ; or
- 15 PBr_3 . The bromide 13 is then reacted with the anion of the ring nitrogen of a compound of formula III, formed using NaH, $LiN(SiMe_3)_3$, $NaN(SiMe_3)_3$, LDA, lithium alkoxide, sodium alkoxide or an appropriate base, in an inert solvent such as THF, DMF, ether, or DME. This yields compounds of formula 14 which contain a chloro-quinazoline or a chloro-thienopyrimidine group. The chloro group is converted to an amino group using NH_3 in ethanol in the presence
- 20 of a catalytic amount of acid, such as HOAc to give compounds of formula 16. Alternatively, the chloro group is converted to a substituted amino group using a primary or secondary amine in an inert solvent. Alternatively, the chloro group is converted to a hydroxy group using acetic acid in water with heating or using a hydroxide source to give compounds of formula 15. Alternatively, the chloro is converted to an alkoxy group using an alcoholic solvent with heated
- 25 in the presence of a base.

An alternative synthesis of quinazolines and thienoquinazolines is outlined in Scheme 6.

Scheme 6.



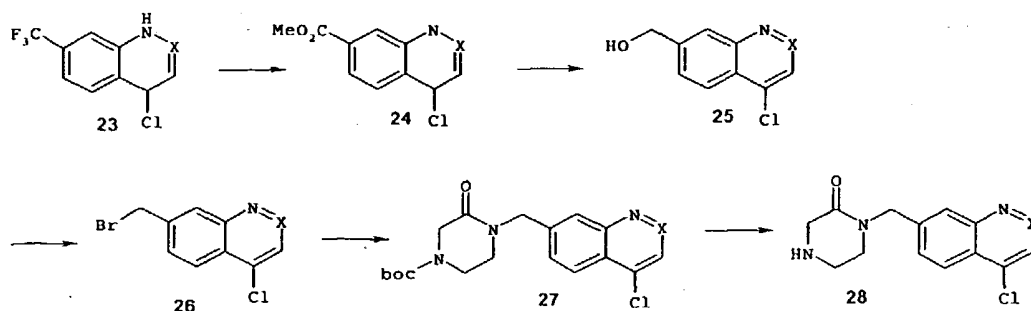
As shown in Scheme 6, an amino-aryl nitrile or an amino heteroaryl nitrile 17 is treated with an aldehyde or ketone under imine forming conditions. The corresponding aryl or heteroaryl imine is brominated using radical bromination with NBS. The bromide is then coupled with compounds of formula IV under basic conditions, such as NaH, LiN(SiMe₃)₃, NaN(SiMe₃)₃, LDA, lithium alkoxides, sodium alkoxides or an appropriate base, in an inert solvent, such as THF, DMF, ether, or DME. This yields compounds of formula 20 in which



is an imino-aryl nitrile or an imino heteroaryl nitrile. The imine is deprotected using an acid such as HCl to give the corresponding aniline. The aniline-aryl-nitrile or the aniline-heteroaryl nitrile 20, is converted to the amino-quinazoline or thienopyrimidine, formula 22 (in which R₂₀=H), using triazine or formamidine. The quinazolinone or thienopyrimidinone, formula 21, in which R₂₀=H, is formed from a compound of formula 20 using formamide. Alternatively, compounds of formula 20 can be reacted under acid conditions, such as HCl (gas) in a solvent such as ethanol in the presence of a nitrile, to give compounds of formula 22 in which R₂₀ is alkyl, aryl or amino depending on the group attached to the nitrile.

The preparation of cinnoline (X = N) and quinoline (X = CH) intermediates is outlined in Scheme 7.

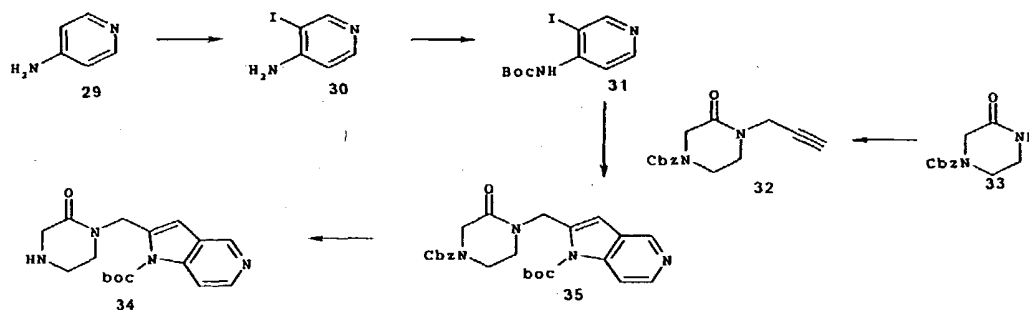
Scheme 7



As shown in Scheme 7, halogenated azaarenes 23, exemplified by 4-chloro-7-trifluoromethylquinoline or cinnoline, are treated with H_2SO_4 (70 -95 %) at 180-220 °C for about 16 to 48 hours in a sealed reaction vessel. The solution is cooled, poured into water and neutralized with base to pH ~ 3-4. The product is dissolved in aqueous base and precipitated by acidification to yield 7-carboxy-4-chloroquinoline or cinnoline. This material is converted to the alkyl ester, such as methyl (24) or ethyl, by standard methods. 7-Alkyloxycarbonyl-4-chloroquinoline or cinnoline is dissolved in an anhydrous, aprotic solvent (THF or ether). The solution is cooled (-60 to -95 °C) and treated with a reducing agent such as lithium aluminum hydride. The solution is warmed (to approximately -40 to -50 °C) for about 15 to 30 minutes and quenched with a solvent such as ethyl acetate. Standard workup gives the product 7-hydroxymethyl-4-chloroquinoline, or cinnoline (25). Material 25 is treated with 45-50 % HBr and heated to about 100-140 °C for about 45 to 90 minutes. After cooling and standard workup, 7-bromomethyl-4-chloroquinoline (or cinnoline) 26 is obtained. Alkylation as described before provides 4-chloroquinoline (or cinnoline) 27 followed by deprotection under the usual acidic conditions gives 4-chloroquinoline (or cinnoline) 28.

The preparation of pyrrolopyridine derivatives is outlined in Scheme 8.

Scheme 8

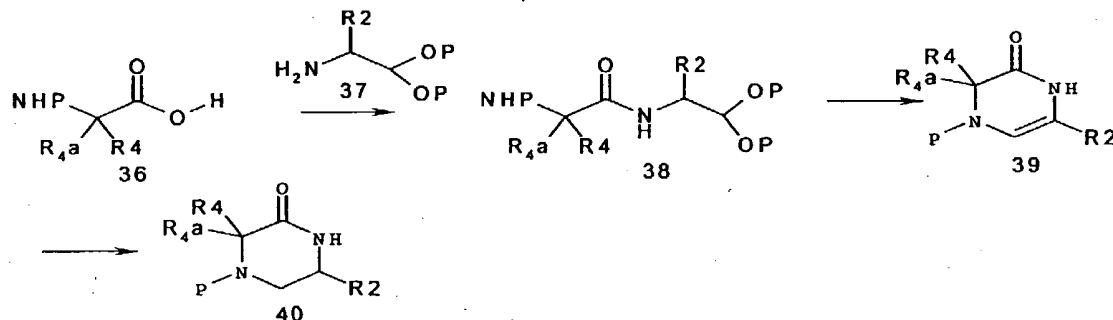


As indicated in Scheme 8, pyrrolopyridine derivatives are prepared by alkylation of a suitably protected oxopiperazine 33 with propargyl bromide in the presence of a base such as sodium hydride. The resulting alkyne 32 is heated (100-120 °C) with a halopyridine 31,

optionally substituted with hydroxy, alkoxycarbonylamino, or sulfhydryl, a catalyst, such as $\text{Pd}(\text{PPh}_3)_2\text{Cl}_2$, copper iodide and triethylamine, in a suitable solvent, such as acetonitrile, in a sealed vessel or in DMF for 2-20 hours. When the pyridine is substituted with an alkoxycarbonylamino moiety, additional treatment with DBU at about 60 °C in DMF yields pyrrolopyridine 35. Subsequent carbamate deprotection using transfer hydrogenation conditions such as Pd black in formic acid yields the desired oxopiperazine pyrrolopyridines 34. After further reaction of 34 with the $\text{L}_1\text{-Cy}_1$ group, an additional deprotection step such as Boc removal using, for example, TFA, HCl is required for generating the oxopiperazine pyrrolopyridines with $\text{L}_1\text{-Cy}_1$ in place. Halopyridine 31 is prepared from iodination of 4-aminopyridine 29 to give iodo-aminopyridine 30 followed by Boc protection.

The preparation of compounds of formula 40 is outlined in Scheme 9.

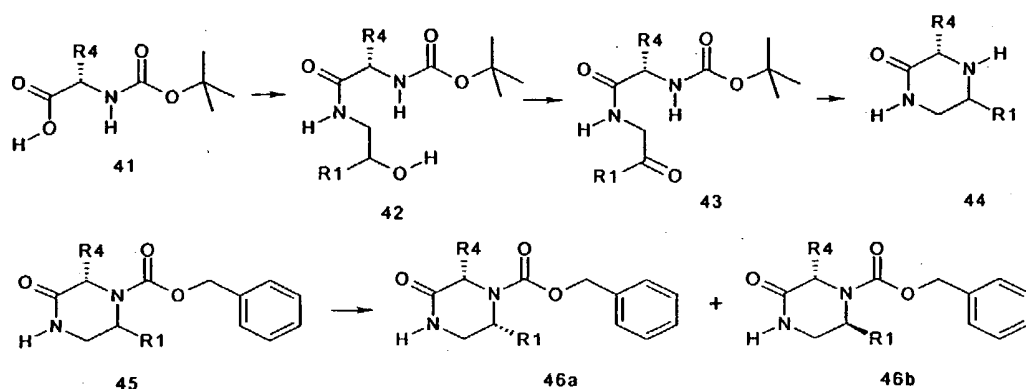
Scheme 9



As shown in Scheme 9, compounds of formula 40 are prepared from an appropriately protected mono- or di- substituted amino-acid 36. To this is added an amino-acetaldehyde, protected as an acetal derivative 37, under standard peptide coupling procedures, employing activating reagents such as EDC, TBTU, or BOP. The resulting dipeptidyl moiety 38 is subjected to conditions which remove the acetal, such as acidic conditions (TsOH). The resulting cyclic material 39 is reduced using hydrogenating conditions to yield a compound of formula 40. This reduction, alternatively, can be carried out using a reagent which acts as a hydride source, such as LAH or NaH..

The preparation of compounds of formula 46a and 46b is outlined in scheme 10.

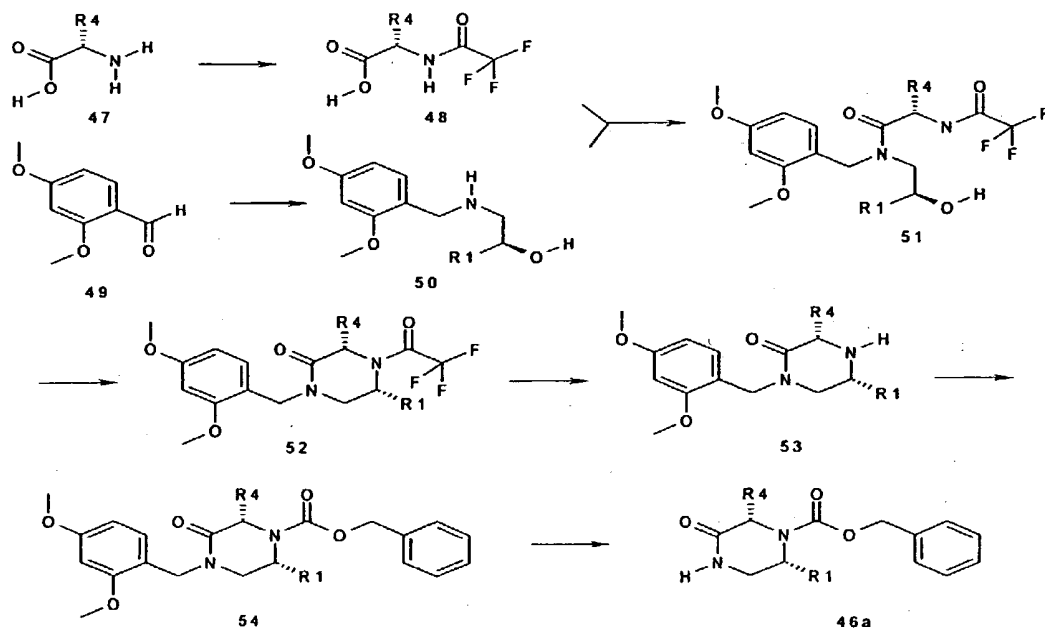
Scheme 10.



As indicated in Scheme 10, a protected amino acid 41 is coupled to a beta-aminoalcohol using standard peptide coupling procedures (iso-propyl chloroformate and triethylamine). The alcohol 42 is then oxidized to a ketone 43 using, for example, Swern oxidation conditions. The protecting group is removed with trifluoroacetic acid and the resulting cyclized compound is reduced under hydrogenation conditions to give the 2-piperidinone 44. The piperazin-2-one ketopiperazine is reacted with N-(benzyloxycarbonyloxy)-succinimide to give a mixture of diastereomers 45 which are separated by chromatographic methods, or in some cases by recrystallization, to give compounds 46a and 46b.

A chiral synthesis of compounds of formula 46a is outlined in Scheme 11.

Scheme 11

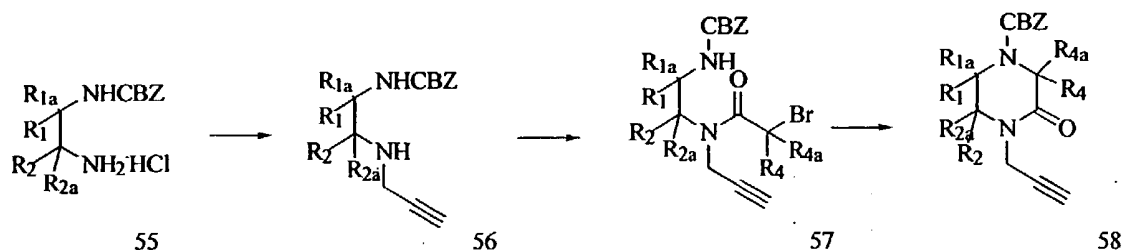


As shown in Scheme 11, amino acid 47 is protected as its trifluoroacetate derivative using trifluoroacetic anhydride and a base to yield compound 48. Amino-alcohol 50 is obtained via reductive amination conditions using a benzaldehyde derivative, such as 2,4-

dimethoxybenzaldehyde 49 and the corresponding primary amine. The resulting amino-alcohol 50 is then coupled to amino-acid 48 using standard peptide coupling procedures (iso-propyl chloroformate and triethylamine) to afford compound 51. Ring closure of compound 51 is then accomplished by utilizing Mitsunobu conditions to yield 2-piperidinone 52. The trifluoroacetate group of compound 52 is removed under basic conditions to give amine 53, which reacts with N-(benzyloxycarbonyloxy)succinimide to give carbamate 54. Deprotection of compound 54 is achieved with an aqueous solution of potassium persulfate and sodium phosphate and heat to produce compound 46a. All possible enantiomers of piperazin-2-one, shown in scheme 2c, can be made from the corresponding amino-alcohol 50 and amino acid 47.

The preparation of the compound of formula 58 wherein R_1 , R_2 , R_{2a} , R_4 and R_{4a} are hydrogen and R_{1a} is carbomethoxy, methoxymethyl, or a protected hydroxymethyl group is shown in Scheme 12.

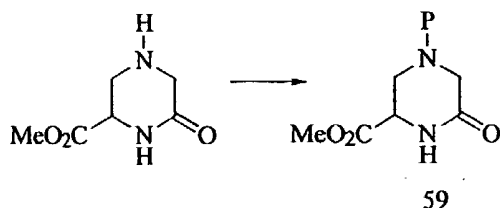
Scheme 12



As shown in Scheme 12, alkynylating a compound of formula 55 with propargyl bromide in the presence of an amine base such as triethylamine provides the compound of formula 56. Coupling with bromoacetic acid using a standard reagent such as DCC gives the compound of formula 57, which can be cyclized using a non-nucleophilic strong base, such as NaH, in a solvent, such as THF, to yield the desired compound of formula 58.

The preparation of a compound of formula 59 is outlined in Scheme 13.

Scheme 13



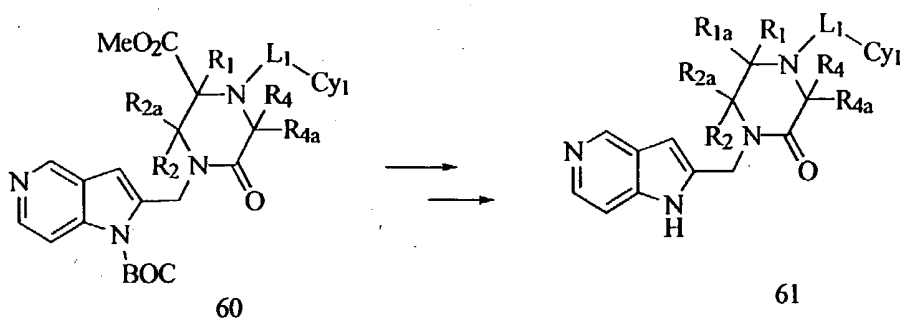
As indicated in Scheme 13, protection of methyl 6-oxopiperazine-2-carboxylate (Aebischer, B., *Helv. Chim. Acta* 1989, 72, 1043-1051) using, for example, benzyl chloroformate or allyl chloroformate under standard conditions provides compound 59.

Alkynylation of 59 with propargyl bromide using a strong base such as NaH in polar solvents as THF or DMF provides the compound of formula 58 (Scheme 12).

The preparation of a compound of formula 61 wherein R_1 , R_2 , R_4 , R_{4a} , L_1 and Cy_1 are as defined in formula I above, and R_{1a} and R_{2a} are independently carboxy, acetamido or

5 hydroxymethyl, is outlined in Scheme 14.

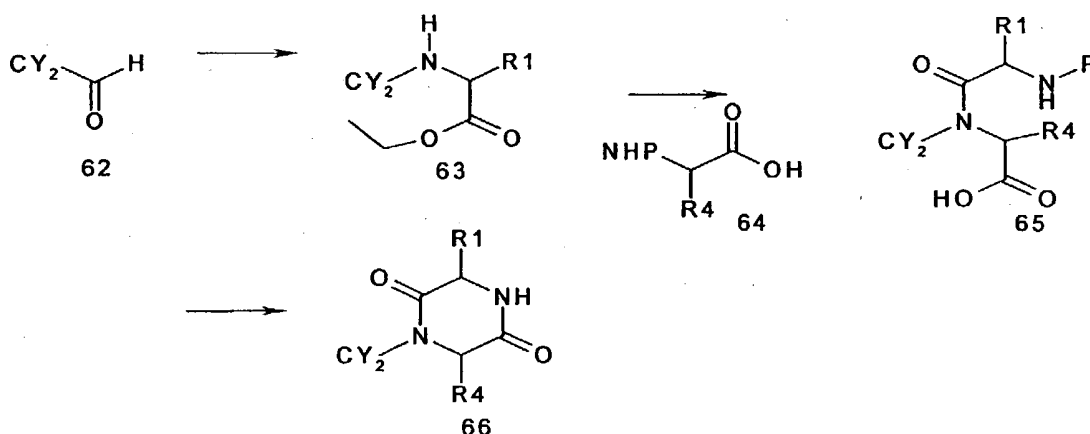
Scheme 14



As shown in Scheme 14, the compound of formula 61 is prepared by hydrolysis of the corresponding ester 60 using a base such as NaOH or LiOH to yield the acid 61. Coupling the acid with a primary or secondary amine or ammonia using standard coupling reagents such as TBTU or EDC gives the amide 61. Alternatively, reduction of the ester 60 using a reducing agent such as $NaBH_4$ yields a hydroxymethyl resin of 61.

The preparation of diketopiperazine compounds of formula 66 is outlined in Scheme 15.

15 Scheme 15

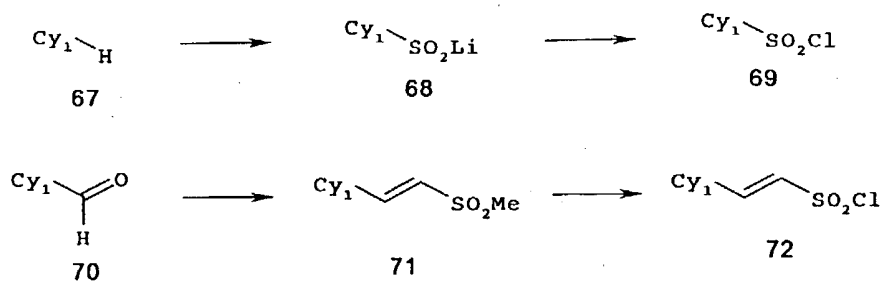


As shown in Scheme 15, an aldehyde 62 containing the Cy_2 group is condensed with an amino acid ester under reductive amination conditions. The resulting secondary amine 63 is then coupled to an N-protected amino acid 64. The resulting dipeptide 65 is deprotected which, in general, results in cyclization to the N- Cy_2 diketopiperazine 66. Alternatively, for dipeptides

65 which do not cyclize, diketopiperazine 66 formation can be achieved using a peptide coupling reagent such as EDC, TBTU, or BOP.

The preparation of sulfonyl chloride intermediates 69 and 72 is outlined in Scheme 16.

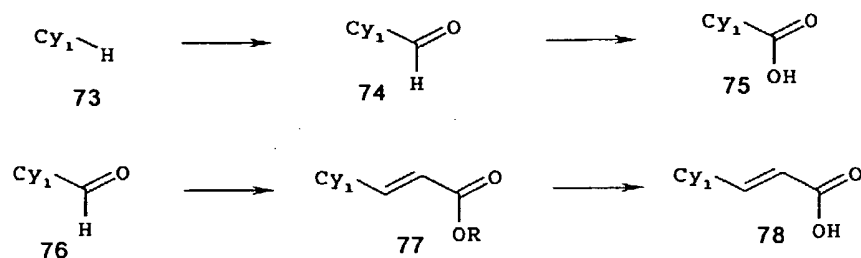
5 Scheme 16



As shown in Scheme 16, Cy_1 substituted sulfonyl chlorides 69 and 72 are prepared by treatment of the appropriate aryl or heteroaryl compounds 67 with a strong base such as $n\text{-BuLi}$ at -78°C followed by the addition of SO_2 gas and treatment of the resulting lithium aryl or heteroaryl sulfonate 68 with a chlorinating agent such as NCS or SO_2Cl_2 to yield compound 69 or, alternatively, by homologation of the appropriate aryl or heteroaryl aldehydes 70 using, for example, ethylmethanesulfonate to yield compound 71 and ethylchlorophosphonate to yield compound 72.

15 The preparation of intermediate compounds 75 and 78 of formula $\text{Cy}_1\text{-CO}_2\text{H}$ is outlined in Scheme 17.

Scheme 17



As shown in Scheme 17, the requisite Cy_1 acids 75 and 78 can be obtained by oxidation of the corresponding alcohols or the aldehydes 74 using, for example, MnO_2 , PDC or AgNO_3 in an appropriate solvent, such as CH_2Cl_2 or $\text{H}_2\text{O}/\text{EtOH}$. The Cy_1 substituted aryl and heteroaryl groups 73 can be functionalized by deprotonation methods using an appropriate non-nucleophilic base such as $n\text{-BuLi}$ in an appropriate solvent such as Et_2O or THF and quenching with an appropriate carbonyl electrophile such as DMF, CO_2 or alkyl chloroformate.

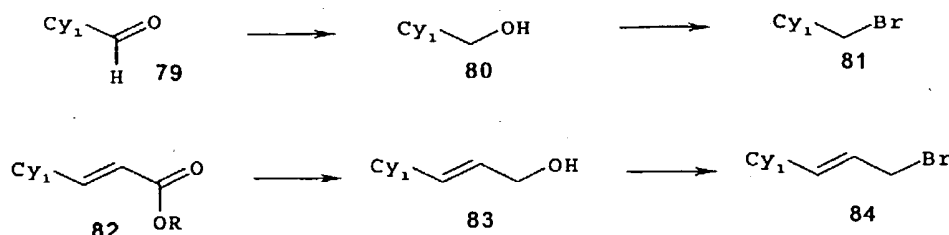
25 Alternatively, the acids can also be generated by hydrolysis of the corresponding esters 77

using, for example, NaOH or LiOH. For example, in the acrylic esters, the Cy_1 -(alkenylene)-groups as defined above are generated by homologation of the Cy_1 aldehydes 76 using the usual Wittig type or Horner-Emmons type reagents in an appropriate solvent such as CH_2Cl_2 or THF.

5

The preparation of Cy_1 alkyl (81) and alkenyl (84) halides is outlined in Scheme 18.

Scheme 18



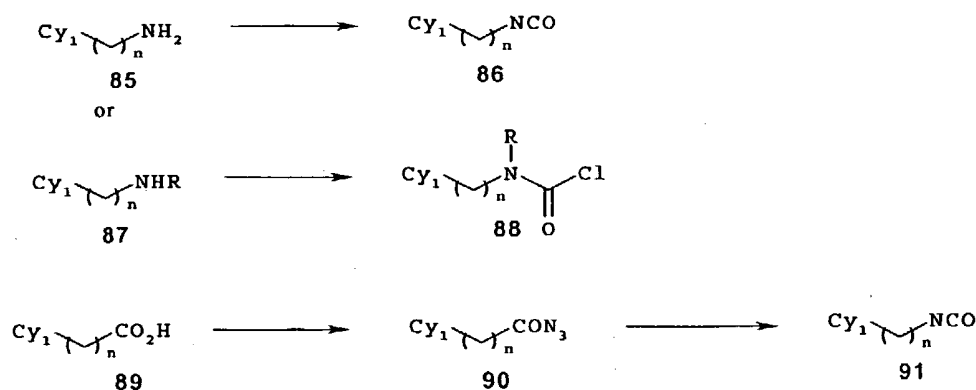
As shown in Scheme 18, Cy_1 alkyl and alkenyl halides 81 and 84 can be prepared by halogenation of the corresponding alcohols 80 and 83 using either NBS, CBr_4 or PBr_3 under standard solvent conditions. The alcohols are generated by reduction of the corresponding aldehydes 79 or esters 82 using $NaBH_4$ or DIBAL in an appropriate solvent.

10

The preparation of Cy_1 isocyanate intermediates 86, 88 and 91 is outlined in Scheme

15 19.

Scheme 19



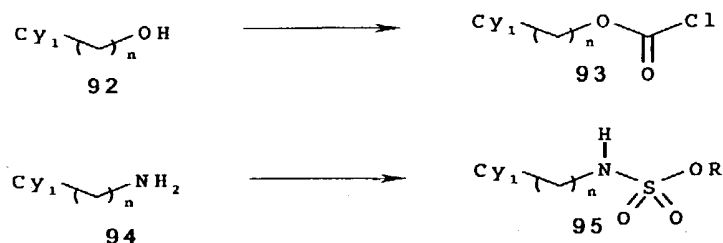
As shown in Scheme 19, Cy_1 isocyanates 86 and 88 are obtained by chlorocarbonylation methods using phosgene or triphosgene in an appropriate solvent such as CH_2Cl_2 with an appropriate base additive such as triethylamine or pyridine on the corresponding primary or secondary amines 85 and 87. Alternatively, the isocyanates 91 can also be generated by Curtius rearrangement in an appropriate solvent such as toluene, p-dioxane or DMF of the corresponding Cy_1 carbonyl azides 90. The carbonyl azides 90, in turn, are derived

20

from the corresponding carboxylic acids 89 using either DPPA reagent or by proceeding through the mixed anhydride via an alkyl chloroformate reagent in an appropriate solvent such as DMF or acetone and using an appropriate base additive such as triethylamine.

- 5 The preparation of Cy₁ chloroformate intermediates 93 and sulfamoyl esters 95 is outlined in Scheme 20.

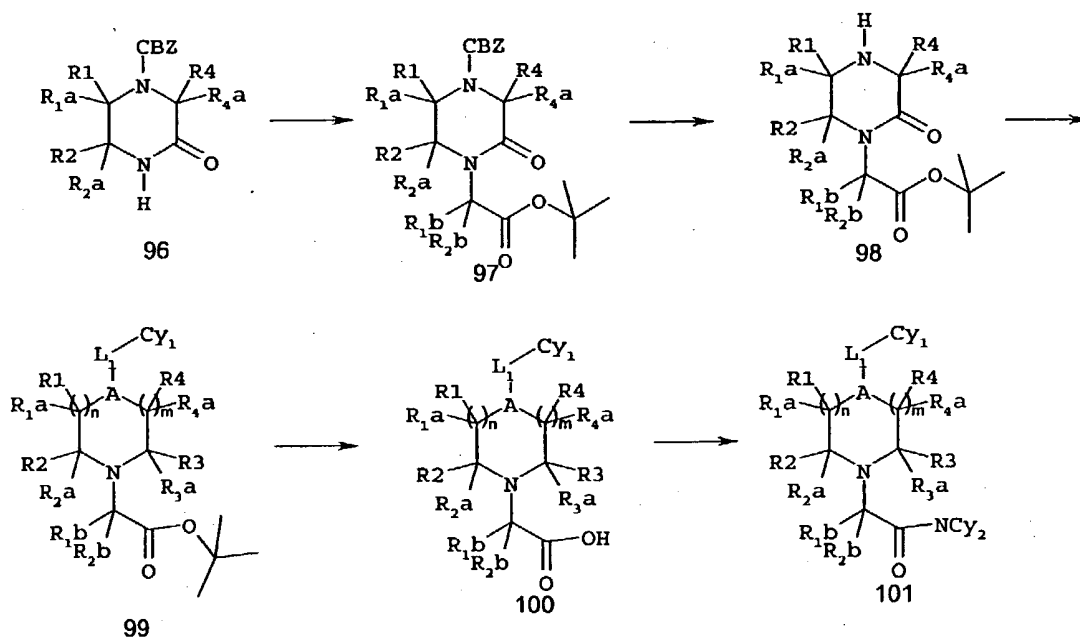
Scheme 20



- 10 As indicated in Scheme 20, Cy₁ chloroformates 93 are obtained by chlorocarbonylation of the corresponding alcohols 92 using reagents such as phosgene, triphosgene or 1,1'-carbonyldiimidazole in an appropriate solvent such as CH₂Cl₂. Activated sulfamoyl esters 95 are prepared from the corresponding amines 94 using catechol sulfate in an appropriate solvent.

- 15 21. The preparation of acetamido compounds 101 of this invention is outlined in Scheme

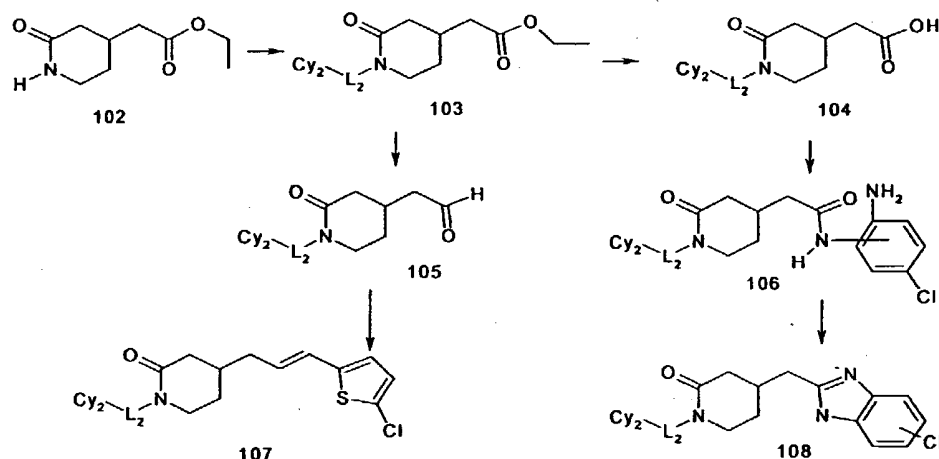
Scheme 21



As indicated in Scheme 21, alkylation of piperazin-2-one 96 is achieved with a strong base such as NaH and a t-butyl ester of haloacetic acid to give the acetate 97. Pd-catalyzed hydrogenation effects removal of the CBZ group from the acetate 97 to give amine 98, which is converted to the L₁-Cy₁ derivative 99 as described in Scheme 1 above. Hydrolysis of t-butyl ester 99 to the corresponding acid 100 is accomplished using, for example, TFA/CH₂Cl₂. The resulting acid 100 is coupled with the optionally protected amine HNCy₂ under typical amide bond formation conditions to give acetamide 101.

The preparation of compounds 107 and 108 of this invention wherein Cy₁ is benzimidazol-2-yl is outlined in Scheme 22.

Scheme 22

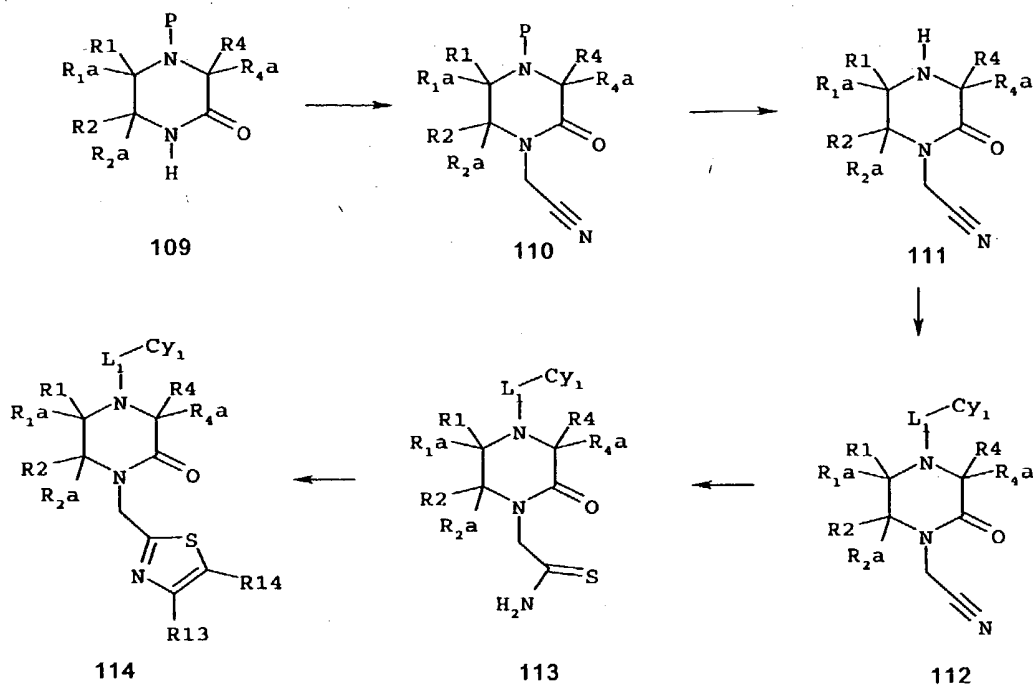


Piperidin-2-one 102 is alkylated by a procedure analogous to that described in Scheme 3 to give the N-Cy₂-L₂ ester derivative 103, which is hydrolyzed to give the acid 104 or reduced to give aldehyde 105. Coupling of the acid 104 with an amine affords amide 106, which is cyclized with acetic anhydride to give the compound 108. Wittig-coupling of aldehyde 105 produces compound 107.

The preparation of the compound of formula 114 is outlined in Scheme 23, wherein R₁, R_{1a}, R₂, R_{2a}, R₄, R_{4a}, L₁, Cy₁, P, are defined in formula I and R₁₃ and R₁₄ are defined herein.

Scheme 23

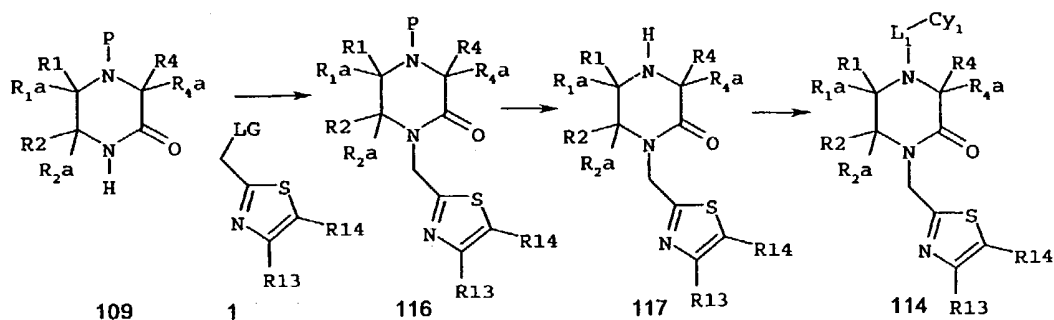
61



As shown in Scheme 23, alkylation of a compound of formula 109 with an appropriate LG-CH₂-CN group wherein LG is a leaving group such as chloro, bromo, iodo, or optionally substituted lower alkylsulfonyloxy or arylsulfonyloxy in an inert organic solvent such as THF, Et₂O or DMF in the presence of a strong base such as NaH, lithium hexamethyldisilylazide or lithium diisopropylamine provides a compound of formula 110. In a preferred aspect, P a tertiaryalkyl or aralkyl carbamate moiety. Removal of the group P can be accomplished by either strong acid such as TFA, a lewis acid or a reagent such as trimethylsilyl iodide to provide a compound of formula 111. Coupling of a compound of formula 111 with an appropriate LG-L-Cy₁ can be performed as previously described in Scheme 1 to give a compound of formula 112 in which the L₁-Cy₁ portion is a sulfonamide, alkyl amine, amide, urea, carbamate or sulfamyl urea. Reaction of a compound of formula 112 with hydrogen sulfide dissolved in ethanol, methanol or another suitable solvent, in the presence of diisopropylethylamine, triethylamine or another suitable base at an elevated temperature, preferably >80 °C, provides a compound of formula 113. A compound of formula 114 can be prepared by heating ketone groups of the formula, R₁₃-C(O)-CH(LG)-R₁₄, with a compound of formula 113 in a suitable high boiling solvent. LG is a leaving group as previously defined. If R₁₃ or R₁₄ contains a protecting group, this group can be removed at this point.

An alternative preparation of a compound of formula 114 (Scheme 23) is shown in Scheme 24.

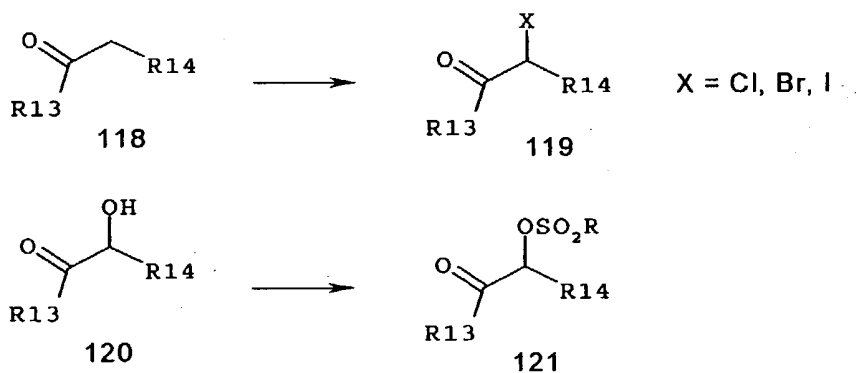
Scheme 24



A compound of formula 116 can be prepared from a compound of formula 109 using conditions previously described in Scheme 3 for the alkylation of Cy_2-LG_2-LG , which is represented by a compound of formula 115. Removal of the group P using a strong acid, strong base or reducing conditions provides a compound of formula 117. A compound of formula 114 is prepared from compound 117 using conditions previously described in Scheme 1.

The preparations of ketone groups of the formula, $R_{13}-C(O)-CH(LG)-R_{14}$ which are shown as compounds of formulas 119 and 121 are outlined in Scheme 25.

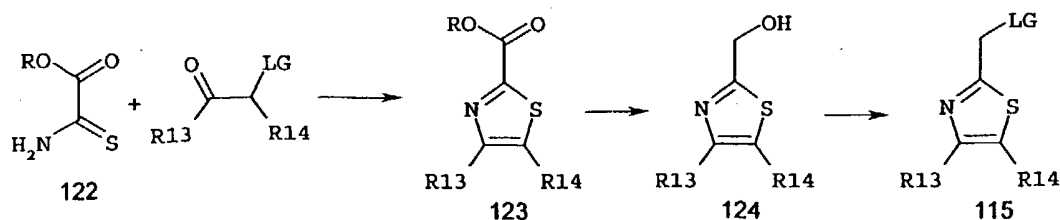
Scheme 25



Halogenation of a compound of formula 118 with an appropriate reagent such as thionyl chloride, bromine, bromine/HOAc, NBS or iodine produces the corresponding halide of formula 119. A compound of formula 120 can be reacted with a sulfonyl chloride and a suitable base such as pyridine or triethylamine to provide a compound of formula 121.

Preparation of thiazole of formula 115 is outlined in Scheme 26.

Scheme 26



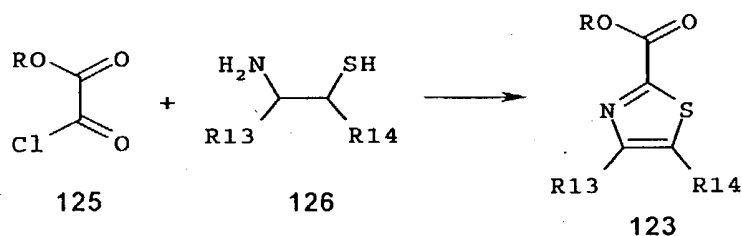
Condensation of a thioamide compound of formula 122 with a ketone of the formula, R₁₃-C(O)-CH(LG)-R₁₄ at elevated temperatures provides the thiazole compound of formula 123. Reduction with LAH, DIBAL or a similar reagent provides the alcohol of formula 124.

- 5 Preparation of the compound of formula 115 can be achieved with PBr₃ to give the bromide (or with a sulfonyl chloride and base to provide the sulfonate ester).

An alternative preparation of a thiazole intermediate of formula 123 is outlined in

Scheme 27

10 Scheme 27



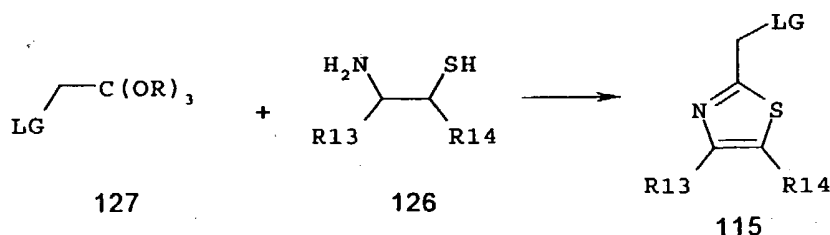
Condensation of a compound of formula 125 with an aminio-thiol compound of formula 126 with a base such as pyridine provides a thiazole of formula 123. This method is especially useful in cases where R₁₃ and R₁₄ are combined to form an aromatic ring system.

15

An alternative preparation of a thiazole intermediate of formula 115 is outlined in

Scheme 28.

Scheme 28



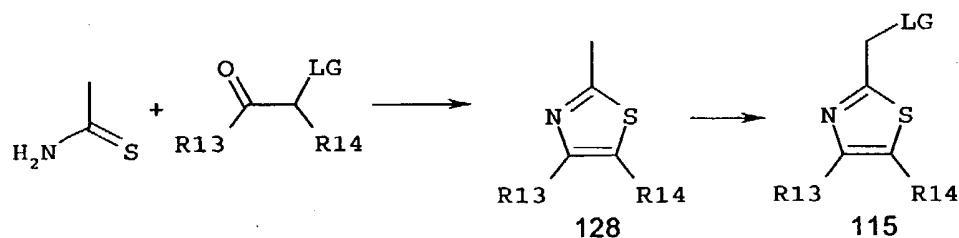
- 20 A compound of formula 127, such as 2-chloro-1,1,1-triethoxyethane, can be condensed with a compound of formula 126 at elevated temperatures to provide a compound of formula

115. This method is especially useful in cases where R_{13} and R_{14} are combined to form an aromatic ring system.

An alternative preparation of thiazole intermediate of formula 115 is outlined in Scheme

29.

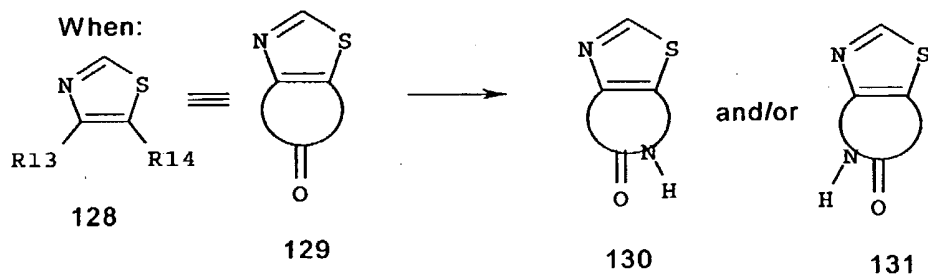
Scheme 29



Condensation of thioacetamide with a ketone of the formula, $\text{R}_{13}-\text{C}(=\text{O})-\text{CH}(\text{LG})-\text{R}_{14}$ at an elevated temperature provides a thiazole of formula 128. Functionalization to provide a leaving group such as Br can be accomplished using NBS and an initiator at an elevated temperature in a solvent such as carbontetrachloride to provide a compound of formula 115. This method is especially useful in cases where R_{13} and R_{14} are combined to form an aromatic ring system.

Ring expansion of a compound of formula 128 to provide lactam products of formulas 130 and 131 is shown in Scheme 30.

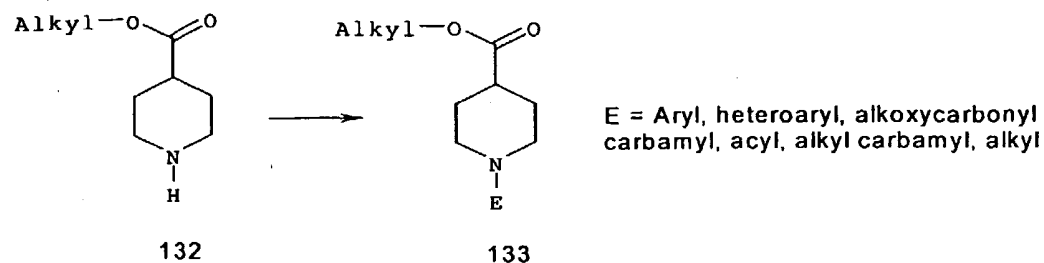
Scheme 30



When R_{13} and R_{14} are combined to form a carbocyclic ring containing a ketone as shown in formula 21, then ring expansion to form the lactone products 130 and 131 can be achieved using the Schmidt reaction. At 0 °C to room temperature a mixture of the ketone 129 is stirred with sodium azide in sulfuric acid and chloroform. The Beckman ring expansion can also be used when the ketone 129 is first treated with hydroxylamine hydrochloride to give the intermediate oxime. An aniline byproduct can also be observed when the Semmler-Wolf aromatization mechanism predominates when thiazole-cyclohexanone substrates are used.

Preparation of an intermediate of formula 133 is shown in scheme 31.

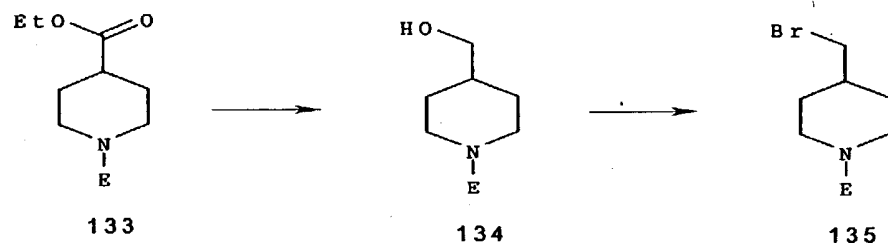
Scheme 31



When E of formula 133 is aryl or heteroaryl, a compound of formula 133 can be prepared using a Pd catalyzed aromatic carbon-nitrogen bond forming reaction developed by Buchwald and Hartwig. This reaction has been reviewed (*Acc. Chem. Res.* 1998 31, 805-818) and can be generalized to include the reaction of an aromatic bromide, chloride or triflate in an inert solvent in the presence of a Pd (0) catalyst and a base such as sodium tert-butoxide, at an elevated temperature, with a primary or secondary amine. When E of formula 133 is alkoxycarbonyl, acyl, alkyl carbamyl or alkyl, the corresponding halide can be used to couple to a compound of formula 132 in the presence of a base. When E of formula 133 is carbamyl, an isocyanate can be used to produce compound 133 from 132.

The preparation of a compound of formula 135 which can be used as an intermediate is outlined in Scheme 32.

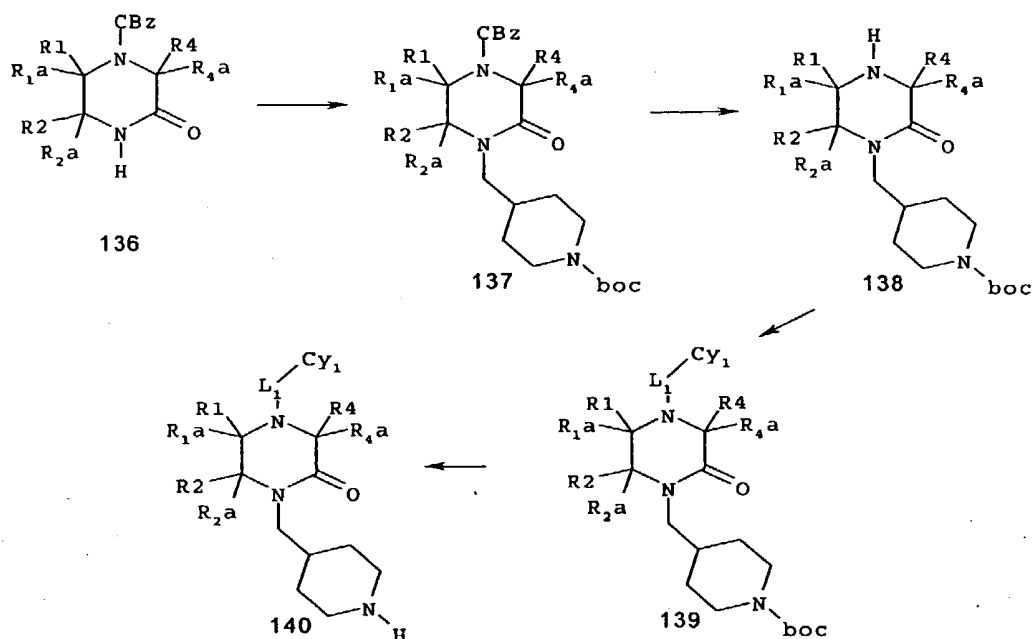
Scheme 32



Reduction of a compound of formula 133 with a reducing agent such as LAH, DIBAL or another similar reagent in a nonprotic solvent can provide an alcohol of formula 134. Conversion of the alcohol 134 into a good leaving group, such as the bromide, can be achieved using $\text{CBr}_4/\text{PPh}_3$ or another similar reagent to provide a compound of formula 135.

The preparation of the compound of formula 140, wherein R_1 , R_{1a} , R_2 , R_{2a} , R_4 , R_{4a} , L_1 , Cy_1 are defined above is outlined in Scheme 33.

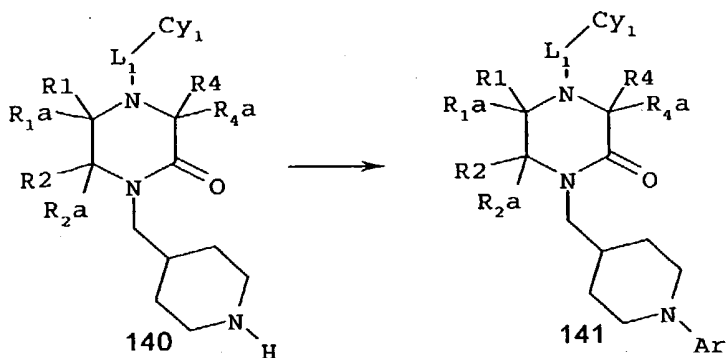
Scheme 33



Alkylation of a compound of formula 136 with a compound of formula 135, where E is
 5 tert-butoxycarbonyl, in an inert organic solvent such as DMF in the presence of a strong base
 such as NaH, lithium hexamethyldisilylazide or lithium diisopropylamine, provides a compound
 of formula 137. Removal of the CBz (benzyloxycarbonyl) group by catalytic hydrogenation in
 an appropriate solvent such as ethanol provides a compound of formula 138. Coupling of a
 compound of formula 138 with LG-L₁-Cy₁ can be performed as previously described above to
 10 give a compound of formula 139 in which the L₁-Cy₁ portion is a sulfonamide, alkyl amine,
 amide, urea, carbamate or sulfamyl urea. Removal of the Boc (t-butoxycarbonyl) group with a
 strong acid, such as TFA, provides a compound of formula 140.

Preparation of a compound of formula 141, where Ar is an aromatic ring, is shown in
 15 scheme 34.
 Scheme 34

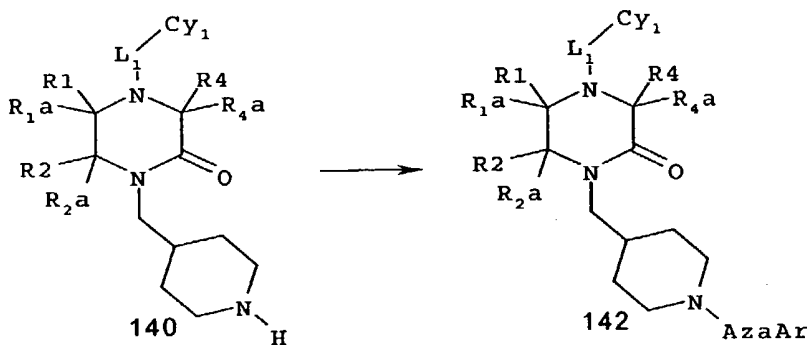
67



A compound of formula 140 can be converted to a compound of formula 141 using a Pd catalyzed aromatic carbon-nitrogen bond forming reaction developed by Buchwald and Hartwig. This reaction has been reviewed (*Acc. Chem. Res.* 1998 31, 805-818) and can be generalized to include the reaction of an aromatic bromide, chloride or triflate in an inert solvent in the presence of a Pd (0) catalyst and a base such as sodium tert-butoxide at an elevated temperature with a primary or secondary amine.

Preparation of a compound of formula 142, where AzaAr is an azaaromatic ring, is shown in scheme 35.

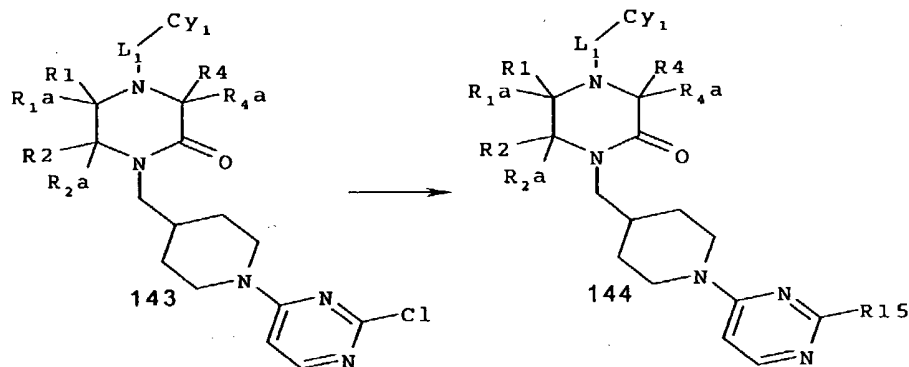
Scheme 35



A compound of formula 142 can be prepared from a halo-substituted azaheteroaromatic compound by heating the halo substituted compound with a compound of formula 140 at an elevated temperature in an inert high boiling solvent such as n-butanol, xylene or NMP. The types of azaheteroaromatic compounds which are best suited for this reaction employ a halogen leaving group in a position of the ring which is activated toward displacement. Such systems are represented by, but not limited to, 2-fluoropyridine, 2-chloroquinoline, 2-chloropyrimidine, 4-chloropyrimidine and 2,4-dichloropyrimidine.

Preparation of a compound of formula 144, where R15 is alkylamine, alkylether or alkylthio, is shown in scheme 36.

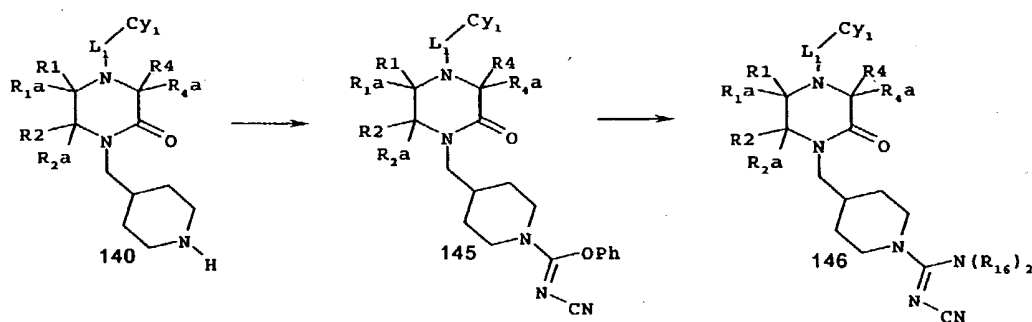
Scheme 36



- 5 A compound of formula 143 can be heated with either an amine, alcohol or thiol in an inert solvent to give the corresponding compound of formula 144.

Preparation of a compound of formula 145 and conversion to a compound of formula 146, where each R16 is independently H or alkyl, is outlined in scheme 37.

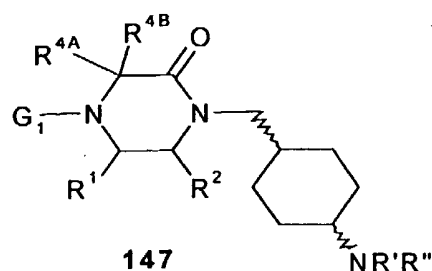
10 Scheme 37



A compound of formula 145 can be prepared by combining a compound of formula 140 with a reagent such as diphenyl cyanocarbonimide at ambient temperature or with heating.

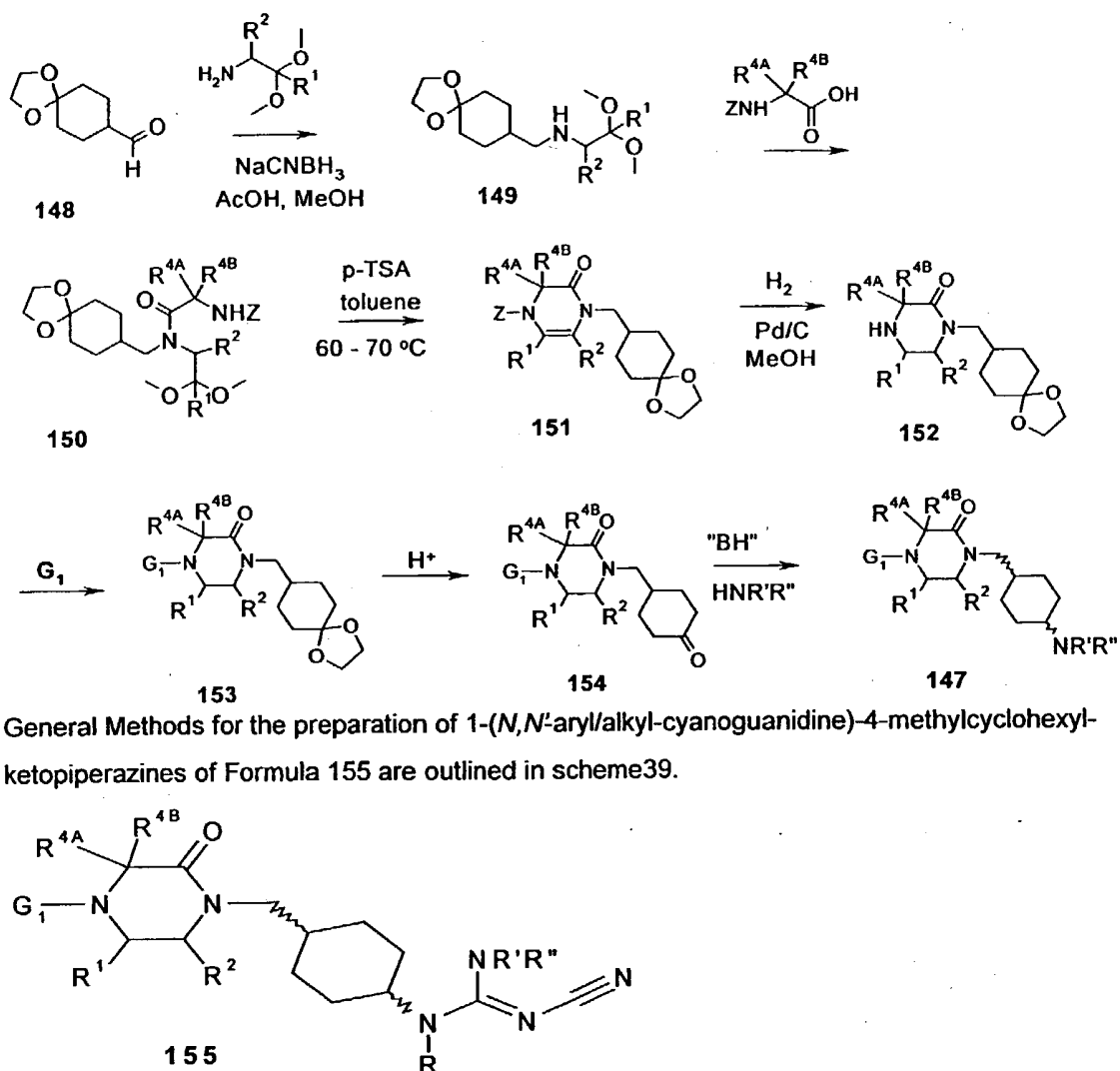
- 15 Heating compound 145 with amine $\text{NH}(\text{R}_{16})_2$, where each R16 is independently H or alkyl, in an inert solvent provides a compound of formula 146.

General Methods for the preparation of 1-(alkyl,aryl)amino-4-methylcyclohexyl-ketopiperazines of Formula 147 are outlined in Scheme 38.



As indicated in the scheme 38, a preferred method of preparation of compounds of formula 147 involves construction of a ketopiperazine 152 containing the cyclic ketal of 4-methylcyclohexan-1-one as an N-1 substituent. Construction of intermediate 152 begins with reductive amination of intermediate 148 (prepared according to the method of Pearson et al.; *J. Org. Chem.* 62, 1997, 5284) with the substituted acetal of aminoacetaldehyde to provide intermediate 149. Intermediate 149 is then acylated with a suitably N-protected substituted α -amino acid to provide intermediate 150. Treatment of intermediate 150 with p-toluenesulphonic acid provides the unsaturated ketopiperazine 151. Deprotective hydrogenation of intermediate 151 provides intermediate 152. Attachment of the moiety G_1 provides intermediate 153. The acetal of the 4-substituted cyclohexanone is hydrolyzed under acidic conditions to provide intermediate 154. Reductive amination with the appropriate amine afford compounds of Formula 147. Reductive amination of the cyclohexanone with the selected amines can be achieved using standard methods known to those skilled in the art using borohydrides such as sodium borohydride or lithium tri-sec-butylborohydride in an appropriate solvent such as methanol or acetic acid at temperatures between 0 and 100 °C. The isomeric cis/trans products of reductive amination can be separated by silica-gel chromatography or RP-HPLC.

Scheme 38

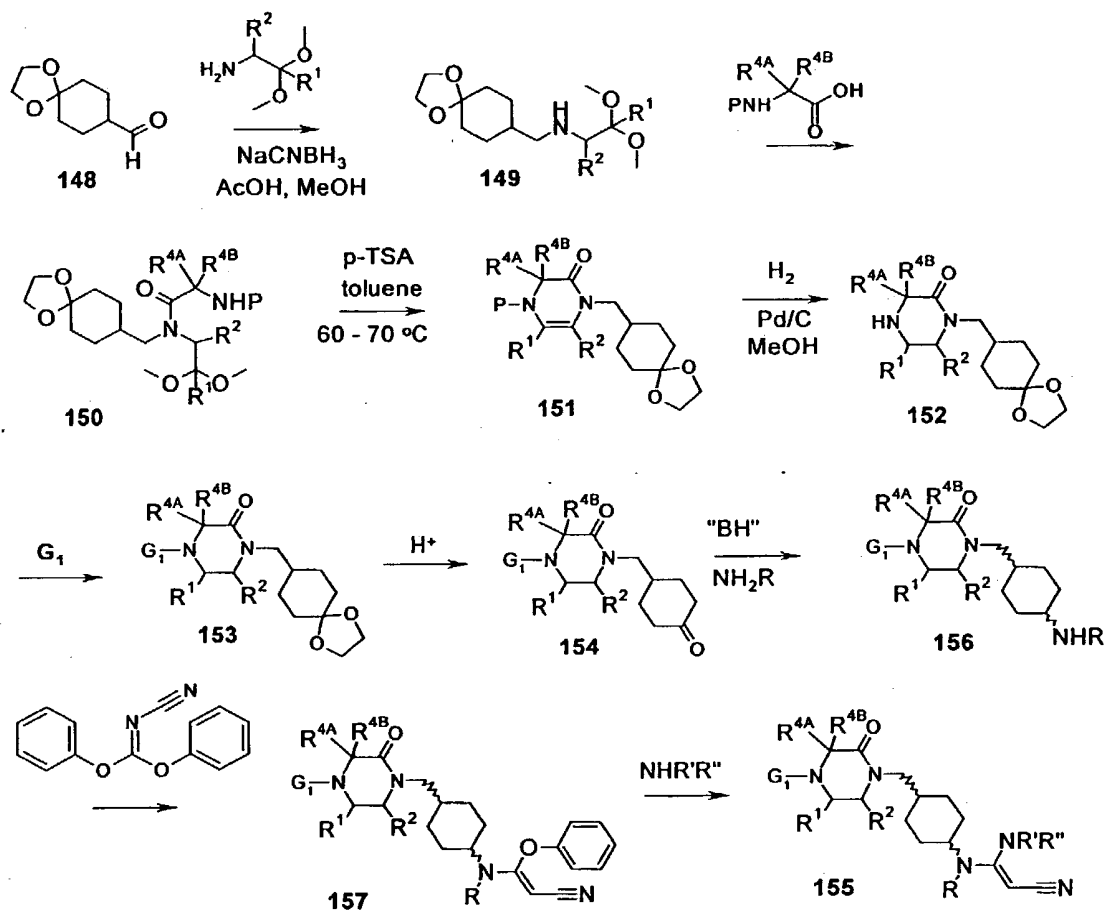


General Methods for the preparation of 1-(N,N'-aryl/alkyl-cyanoguanidine)-4-methylcyclohexyl-ketopiperazines of Formula 155 are outlined in scheme 39.

- 5 As shown in scheme 39, a preferred method of preparation of compounds of formula 155 involves construction of a ketopiperazine 152 containing the cyclic ketal of 4-methylcyclohexan-1-one as an N-1 substituent. Construction of intermediate 152 begins with reductive amination of intermediate 148 (prepared according to the method of Pearson et al.; *J. Org. Chem.* 62, 1997, 5284) with the substituted acetal of aminoacetaldehyde to provide intermediate 149.
- 10 Intermediate 149 is then acylated with a suitably N-protected substituted α-amino acid to provide intermediate 150. Treatment of intermediate 150 with p-toluenesulphonic acid provides the unsaturated ketopiperazine 151. Deprotective hydrogenation of intermediate 151 provides intermediate 152. Attachment of the moiety G₁ provides intermediate 153. The acetal of the 4-substituted cyclohexanone is hydrolyzed under acetic conditions to provide intermediate 154.
- 15 Reductive amination with the appropriate primary amine provides intermediate 156. Reductive amination of the cyclohexanone with the selected amines can be achieved using standard

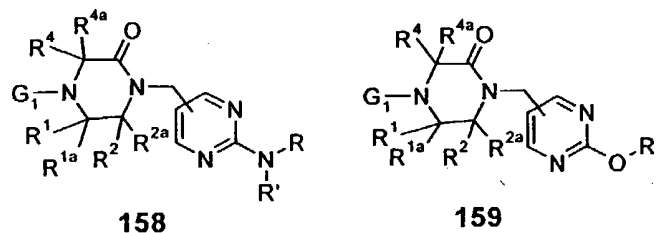
methods known to those skilled in the art using borohydrides such as sodium borohydride or lithium tri-sec-butylborohydride in an appropriate solvent such as methanol or acetic acid at temperatures between 0 and 100 °C. The isomeric cis/trans products of reductive amination can be separated by silica-gel chromatography or RP-HPLC. Intermediate 156 is reacted with diphenyl cyano-carbonimide to provide intermediate 157. Intermediate 157 is reacted with appropriate primary and secondary amines to provide a compound of Formula 155.

Scheme 39



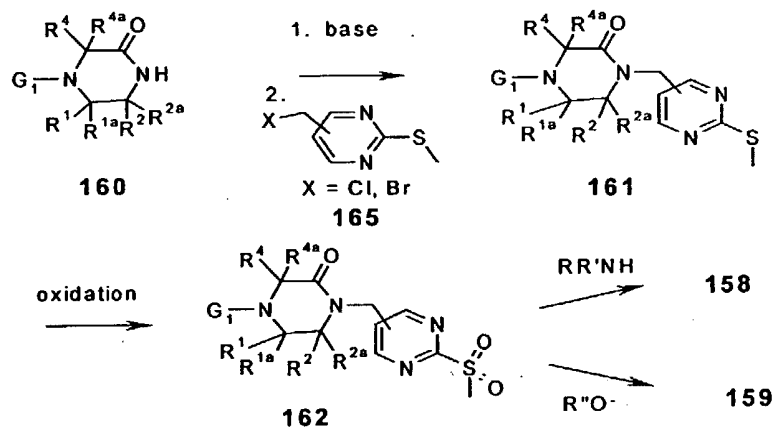
General Methods for the preparation of 2-substituted-4&5-methylpyrimidyl-

ketopiperazines of Formulas 158 & 159 are outlined in Scheme 40 below.



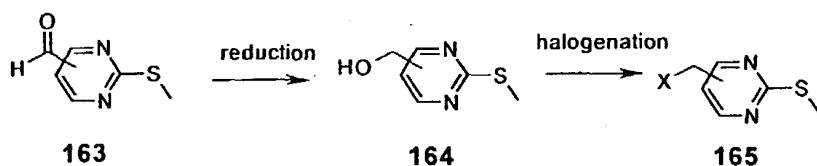
As shown in scheme 40, a preferred method of preparation of compounds of formula 158 and 159 involves alkylating a ketopiperazine intermediate 160 containing a desired N-4 substituent (designated G-1) with either 4 or 5-halomethyl 2-thiomethylpyrimidine to provide intermediate 161. Oxidation of the thiomethyl group of intermediate 161, to provide intermediate 162, followed by displacement with the appropriate amine or alkoxide affords compounds of Formula 158 or 159, respectively. Alkylation of the amide of intermediate 160 can be achieved using standard methods known to those skilled in the art such as deprotonation with NaH in DMF or *t*-butoxide in *t*-butanol at temperatures between -78 and 100°C followed by addition of the halide intermediate 165 and stirring at 0 to 100°C for 0.5 hours to 24 hours. Oxidation of the sulfide of intermediate 161 to the sulfone of intermediate 162 can be accomplished in standard fashion, such as using oxone in a mixture of MeOH and H₂O or *m*-CPBA in CH₂Cl₂. Displacement of the sulfone of intermediate 162 with the appropriate amine can be achieved by simply stirring the components neat or in an unreactive solvent such as CH₂Cl₂ or DMF for 0.5 to 24 hours at 20 to 100°C. Similarly, reaction of an alkoxide in an inert solvent leads to the desired displacement product.

Scheme 40



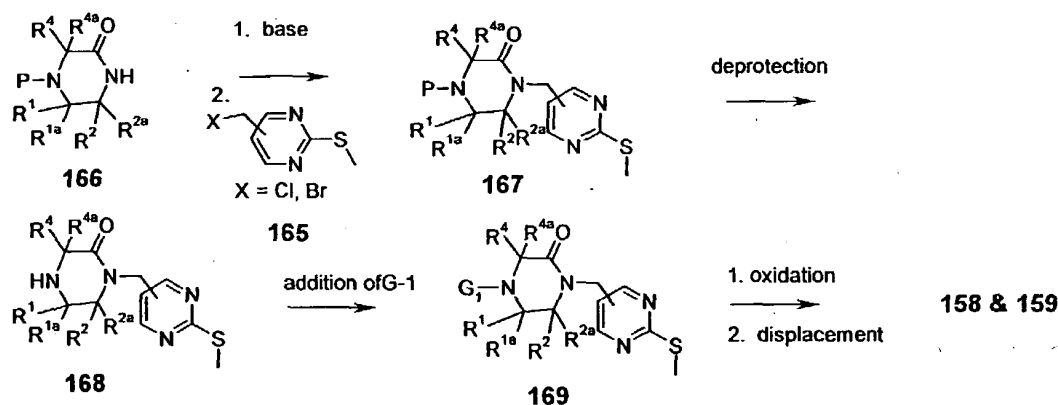
The 4&5-halomethyl-2-methylthiopyrimidines intermediates 165 can be prepared as illustrated in scheme 41 from the corresponding 4&5-carboxaldehydes intermediate 163, respectively. 2-Methylthiopyrimidine-4-carboxaldehyde can be prepared using the procedure of Bredereck et al. (*Chem. Ber.* 1964, 3407). 2-Methylthiopyrimidine-5-carboxaldehyde can be prepared by the procedure of Gupton et al. (*J. Het. Chem.* 28, 1991, 1281).

Scheme 41



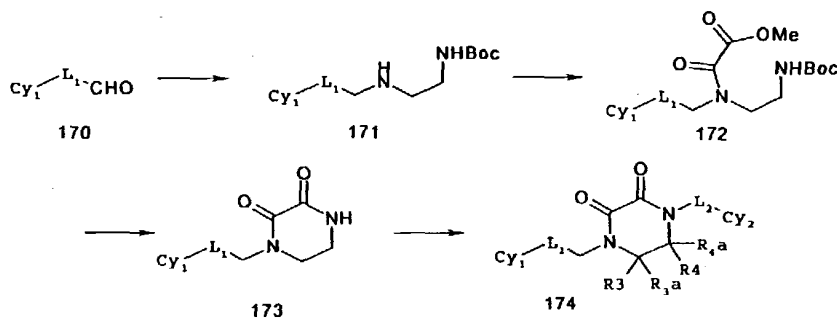
Alternatively, as illustrated in scheme 42, compounds of formula 158 and 159 can be prepared by alkylating suitably protected [at N-4 (designated P)] ketopiperazine intermediate 166, with either the 4- or 5-halomethyl-2-methylthiopyrimidine (intermediate 165) to provide intermediate 167. The protecting group of intermediate 167 can then be removed to provide intermediate 168 and the desired G-1 substituent added to provide intermediate 169. Suitable protecting groups include Boc, Cbz, Alloc and Fmoc, which can be manipulated in the usual manner.

Scheme 42



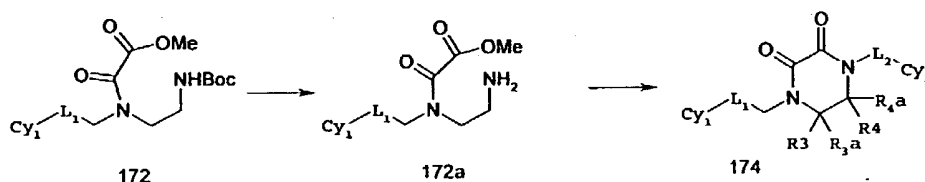
Diketopiperazine compounds of formula I, in which A is N, both R_1 and R_{1a} taken together and R_2 and R_{2a} taken together are oxygen, are prepared in general as described in *J. Org. Chem.* 1998, 63, 4131 and *Chem. Pharm. Bull.* 1981, 29, 684. The synthetic route used is outlined in Scheme 43 below.

Scheme 43



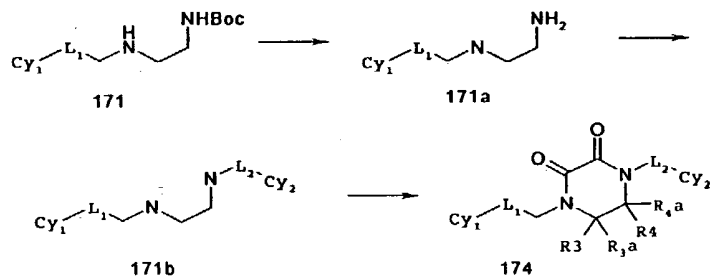
As shown in Scheme 43 above, an aryl, heteroaryl or biaryl aldehyde or alkenyl aldehyde derivatives representative of Cy_1-L_1 groups defined herein can be aminated with a suitably protected form of ethylenediamine using a reducing agent such as sodium borohydride. The secondary amine 171 is treated with an appropriate form of oxalyl chloride, notably methyl chlorooxoacetate, in the presence of base to form oxalamic ester intermediate 172. 2,3-Diketopiperazine 203 is formed by removal of the protecting group under acidic conditions (HCl or TFA) followed by cyclization under base conditions (TEA). Appropriate Cy_2-L_2 groups can be appended to compounds of formula 173 by alkylation with a suitable aryl chloromethyl or bromomethyl ring system, such as a compound of formula 179 using NaH, $LiN(SiMe_3)_3$, $NaN(SiMe_3)_3$, LDA, or an appropriate base, in an inert solvent such as THF or DMF to provide compounds of formula 174 in which Cy_2 is a chloroquinazoline, chloroquinoline, aminoquinazoline or another group defined herein.

Scheme 43A



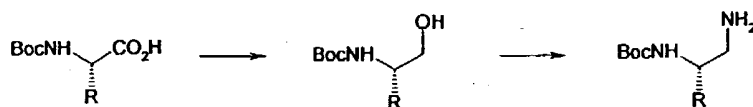
As shown in Scheme 43 A above deprotection of oxalamic ester intermediate 172 under acidic conditions can also be used to isolate intermediate 172a (Scheme 43A) and followed directly by reductive amination conditions with aryl aldehydes to incorporate the respective Cy_2-L_2 groups using a reducing agent such as sodium borohydride or sodium cyanoborohydride. Ring closure occurs under these conditions to provide the 2,3-diketopiperazines 174 *in situ*.

Scheme 43B



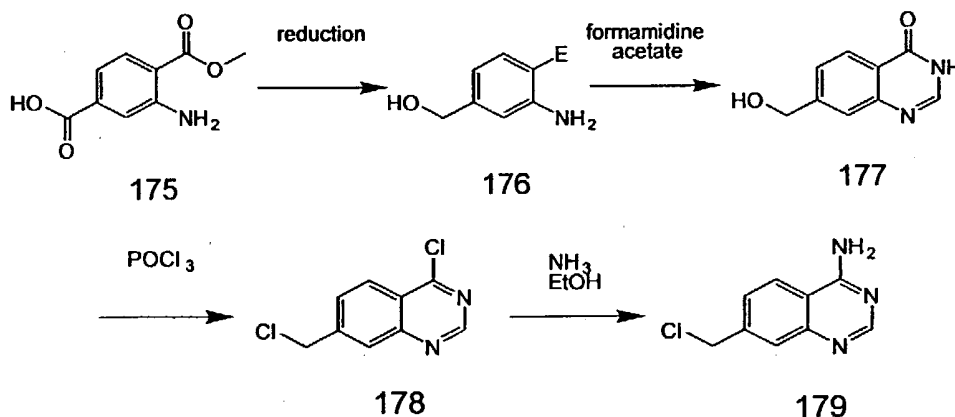
Alternatively, the route shown above in Scheme 43B can be used by deprotecting the secondary amine 171 under acidic conditions (HCl or TFA) to diamine 171a and followed directly by reductive amination with aryl aldehydes to incorporate the respective Cy_2-L_2 groups using a reducing agent such as sodium borohydride or sodium cyanoborohydride. Diamine 171b is then cyclized by reacting with dimethyl oxalate to provide 2,3-diketopiperazines 174.

Scheme 43C



As shown in Scheme 43 C above substituted unsymmetrical ethylenediamine units can be employed by preparing from corresponding amino acids (Scheme 43C). Formation of the mixed anhydride from the acid moiety (iso-butyl chloroformate) followed by reduction (sodium borohydride) gives the respective amino alcohol intermediate. The alcohol moiety can be derivatized as the mesylate (methanesulfonyl chloride), converted to the azide (sodium azide) and reduced by hydrogen to generate the appropriately protected ethylenediamines.

Scheme 44



As shown in Scheme 44, the quinazoline 179 can be prepared by reduction of the acid 175 with Super Hydride in THF to afford the alcohol 176. The alcohol 176 is then reacted in formamide at about 180°C to afford cyclised compound 177. The cyclised compound 177 is then converted to its chloro derivative 178, by reacting with POCl_3 . The chloro derivative 178 is then converted to the amino compound 179 by using NH_3 in ethanol or $\text{NH}_4\text{OAc/PhOH}$.

This invention is further exemplified but not limited by the following examples which further illustrate the preparation of the compounds of this invention. The starting materials and intermediates are prepared by the application or adaptation of known methods, for example methods used heretofore or described in the literature, for example those described by R. C. Larock in Comprehensive Organic Transformations, VCH publishers, 1989.

The compounds of the invention, their methods or preparation and their biological activity will appear more clearly from the examination of the following examples which are presented as an illustration only and are not to be considered as limiting the invention in its scope.

EXAMPLE 1. 6-Chlorobenzo[b]thiophene-2-sulfonyl chloride.A. 1-Chloro-3-(2,2-dimethoxyethylsulfanyl)benzene.

To a solution of 3-chlorothiophenol (2.4 g, 16.6 mmol) in THF (200 mL) at 0°C is added
5 bromoacetaldehyde dimethyl acetal (2.8 g, 16.6 mmol). To the solution is added sodium
hydride (60% mineral oil dispersion, 0.70 g, 17.4 mmol). The reaction is stirred for 16 hours,
and then is quenched by the addition of saturated NH₄Cl (aq.). The solution is diluted with
EtOAc. The organic layer is washed with a saturated NaCl (aq.). The organic layer is dried
over MgSO₄, filtered and concentrated. The crude product is purified by column
10 chromatography eluting with hexanes. The title compound (3.7 g, 15.9 mmol) is obtained as an
oil. ¹H NMR (CDCl₃, 300MHz) δ 7.32 (m, 1H), 7.25 (m, 1H), 7.12 (m, 1H), 4.47 (m, 1H), 3.07 (s,
3H), 3.02 (s, 3H).

B. 4-Chlorobenzo[b]thiophene and 6-Chlorobenzo[b]thiophene.

A solution containing polyphosphoric acid (8 g) and chlorobenzene (50 mL) is heated at
15 reflux. A solution containing 1-chloro-3-(2,2-dimethoxyethylsulfanyl)benzene (2.7 g, 11.6 mmol)
in chlorobenzene (5 mL) is added dropwise to the refluxing polyphosphoric acid solution. After
6 hours, the solution is cooled to ambient temperature. The solution is diluted with CH₂Cl₂ and
washed with water and saturated NaCl (aq.). The organic layer is dried over MgSO₄, filtered
and concentrated. The crude product is purified by column chromatography eluting with
20 hexanes to yield the title compounds (2.4 g, 9.0 mmol) as a 1:1 isomeric mixture. ¹H NMR
(CDCl₃, 300MHz) δ 7.88 (m, 1H), 7.75 (m, 2H), 7.42 (m, 2H). MS (EI): m/z 168, 170 (M⁺), Cl
pattern.

C. 4-Chlorobenzo[b]thiophene-2-sulfonyl chloride and 6-Chlorobenzo[b]thiophene-2-sulfonyl
chloride.

25 To a solution of 4-chloro-benzo[b]thiophene and 6-chlorobenzo[b]thiophene (11.8 g,
88.1 mmol), in 400 mL of THF at -78°C is added n-BuLi (55 mL of a 1.6M solution in hexanes,
88.1 mmol). After 15 minutes, the solution is added by cannula to a precooled (-78°C) solution
of SO₂ (200 g) in 100 mL of THF. After addition, the solution is allowed to warm to ambient
temperature. After 0.5 hour, the solution is concentrated. The residue is suspended in
30 hexanes (400 mL) and is cooled to 0°C. To the solution is added SO₂Cl₂ (12.5 g, 92.5 mmol).
After stirring for 15 minutes, the solution is concentrated. The residue is dissolved in EtOAc.
The organic solution is washed with saturated NH₄Cl (aq.), H₂O and saturated NaCl (aq.). The
organic layer is dried over MgSO₄, filtered and concentrated. The crude product is dissolved in
CH₂Cl₂ and filtered through a plug of silica gel. The crude product is purified by column

chromatography eluting with hexanes to yield the title compound as well as 4-chlorobenzo[b]thiophene-2-sulfonyl chloride as white solids.

4-Chlorobenzo[b]thiophene-2-sulfonyl chloride: ^1H NMR (CDCl_3 , 300MHz) δ 8.32 (m, 1H), 7.81 (m, 1H), 7.53 (m, 2H).

5 6-Chlorobenzo[b]thiophene-2-sulfonyl chloride: ^1H NMR (CDCl_3 , 300MHz) δ 8.11 (s, 1H), 7.88 (m, 2H), 7.50 (m, 1H).

EXAMPLE 2. 5'-Chloro-[2,2']bithiophenyl-5-sulfonyl chloride.

A. 5-Chloro-[2,2']bithiophene.

10 The title compound is prepared from 2-chloro-thiophene according to the procedure described in Bull. Chem. Soc. Japan, 1979, 1126. The crude product is purified by column chromatography eluting with a gradient of 5% EtOAc/hexanes to 10% EtOAc/hexanes to afford a white solid. ^1H NMR (CDCl_3 , 300MHz) δ 7.24 (m, 1H), 7.11 (d, 1H), 7.03 (dd, 1H), 6.94 (d, 1H), 6.83 (d, 1H). MS (EI) $[M^+]$ = 200, 202, Cl pattern.

15 B. 5'-Chloro-[2,2']bithiophenyl-5-sulfonyl chloride.

The title compound is prepared as described in Example 1, Part C using 5-chloro-[2,2']bithiophene in place of 6-chloro-benzo[b]thiophene. The crude product is purified by column chromatography eluting with a gradient of 5% EtOAc/hexanes to 10% EtOAc/hexanes to give a white solid. ^1H NMR (CDCl_3 , 300MHz) δ 7.76 (d, 1H), 7.14 (d, 1H), 7.09 (d, 1H), 6.92 (d, 1H). MS (EI): m/z 298, 300 (M^+), Cl pattern.

20

EXAMPLE 3. 2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl chloride.

A. 2-(5-Chloro-thiophen-2-yl)-ethenesulfonic acid ethyl ester.

n-Butyllithium (53.1 mL, 2.5M solution in hexanes) is added dropwise to a solution of
25 ethylmethanesulfonate (12.9 mL, 0.12 mol) in THF (300 mL) at -78°C . The reaction mixture is stirred for 15 min then ethylchlorophosphonate (9.9 mL, 0.07 mol) is added dropwise. The solution is stirred at -78°C for 30 minutes and then heated to 50°C for 1 hour. The reaction mixture is then cooled to -78°C and stirred for 1 h then 5-chlorothiophenecarboxaldehyde (7.1 mL, 0.07 mol) is added dropwise. The reaction mixture is allowed to slowly warm to RT
30 overnight. Water (30 mL) is added to the mixture and stirred for 15 min then concentrated in vacuo. The residue is taken up in CH_2Cl_2 and washed with water, brine, dried over MgSO_4 , filtered and concentrated to dryness. The crude product is purified by column chromatography eluting with 5% EtOAc/hexanes to give title product (11.3 g, 0.04 mol) as an oil. ^1H NMR (CDCl_3 , 300MHz) δ 7.51 (d, 1H), 7.10 (d, 1H), 6.91 (d, 1H), 6.42 (d, 1H), 4.20 (q, 2H), 1.40 (t, 3H).
35

B. 2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl chloride.

Tetrabutylammonium iodide (16.3 g, 44.2 mmol) is added to a solution of 2-(5-chloro-thiophen-2-yl)-ethenesulfonic acid ethyl ester (11.3 g, 40.2 mmol) in acetone (100 mL) at room temperature. The mixture is heated to reflux and stirred overnight then cooled to RT and concentrated in vacuo. The residue is taken up in CH₂Cl₂ then washed with water and brine. The organic layer is dried over MgSO₄, filtered and concentrated to dryness to give an oil (18.74 g, 40.2 mmol) which is taken on to the next step without further purification. Sulfuryl chloride (7.1 mL, 88.5 mmol) is added to a solution of triphenylphosphine (21.0 g, 86.42 mmol) in CH₂Cl₂ at 0°C. The ice bath is then removed and the product (18.74 g, 40.2 mmol) from the above reaction is added. After 2 h, the reaction mixture is concentrated in vacuo and the product purified by column chromatography eluting with 10% EtOAc/Hexanes to give the title compound (6.4 g, 26.3 mmol) as an off-white solid. ¹H NMR (CDCl₃, 300 MHz) δ 7.70 (d, 1H), 7.23 (d, 1H), 7.00 (d, 1H), 6.91 (d, 1H).

EXAMPLE 4. 3-Chlorobenzyl sulfamyl catechol.

To a solution of 3-chlorobenzylamine (0.14 g, 1.0 mmol) in 3 mL of DMF is added Et₃N (0.10 g, 1.5 mmol). The solution is cooled to 0°C. Catechol sulfate (0.172 g, 1.0 mmol) is added. The solution is warmed to ambient temperatures. After 2.5 h, 30 mL of EtOAc is added. The solution is washed with 5% HCl, H₂O and saturated NaCl. The organic layer is dried over MgSO₄, filtered and concentrated to give the title compound (0.30 g, 0.97 mmol). ¹H NMR (d6-DMSO, 300 MHz) δ 9.94 (s, 1H), 8.82 (m, 1H), 7.41 (m, 4H), 7.19 (d, 1H), 7.10 (m, 1H), 6.95 (d, 1H), 6.79 (m, 1H), 4.32 (AB, 2H).

EXAMPLE 5. 2-Bromomethyl-6-chlorobenzo[b]thiophene.

A. 6-Chlorobenzo[b]thiophene-2-carboxaldehyde.

To a solution of 6-chlorobenzo[b]thiophene (1.0 g, 5.93 mmol) in THF (60 mL) at -78°C is added a 1.6 M solution of n-BuLi in THF (3.9 mL, 6.23 mmol). After 10 minutes, 0.5 mL of DMF is added. The solution is stirred for 0.5 hours, then allowed to warm to ambient temperature. The solution is poured into a solution of saturated NH₄Cl. The solution is diluted with ether and the layers are separated. The organic layer is washed with H₂O and saturated NaCl. The organic layer is dried over MgSO₄, filtered and concentrated. The title compound is obtained as a white solid. MS (EI): m/z 196 (M⁺).

B. 6-Chlorobenzo[b]thiophen-2-yl)methanol.

To a solution of 6-chlorobenzo[b]thiophene-2-carboxaldehyde in THF at 0°C is added NaBH₄. After 1 hour, the solution is diluted with saturated NH₄Cl and ether. The organic layer

is washed with H₂O and saturated NaCl, dried over MgSO₄, filtered and concentrated. ¹H NMR (CDCl₃, 300 MHz) δ 7.82 (s, 1H), 7.60 (d, 1H), 7.40 (m, 2H), 4.91 (AB, 2H).

C. 2-Bromomethyl-6-chlorobenzo[b]thiophene.

To a solution of 6-chlorobenzo[b]thiophen-2-yl-methanol (0.2 g, 1.01 mmol) in THF (10 mL) is added triphenyl phosphine (0.34 g, 1.31 mmol) followed by CBr₄ (0.42g, 1.26 mmol). After 3 hours, the solution is concentrated. The product is purified by column chromatography eluting in a gradient of 5% EtOAc/hexanes to 10% EtOAc/hexanes. The product is obtained as a white solid (0.25 g, 0.53 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 7.82 (s, 1H), 7.62 (d, 1H), 7.40 (m, 2H), 4.76 (s, 2H).

EXAMPLE 6. 5-Bromomethyl-5'-chloro-[2,2']bithiophenyl.

A. (5'-Chloro-[2,2']bithiophenyl-5-yl)-methanol.

To a solution of 5-chloro-[2,2']bithiophenyl (3.00 g, 14.9 mmol) in 30 mL of THF at 0°C is added n-BuLi (9.8 mL of a 1.6M solution in hexanes, 15.7 mmol) dropwise. DMF (2.30 mL, 30 mmol) is added dropwise and the resulting solution is heated at reflux for 1 hour. The solution is diluted with H₂O and extracted with Et₂O. The organic layer is washed with H₂O and saturated NaCl solution, then dried over MgSO₄, filtered and concentrated. The crude aldehyde is dissolved in 40 mL of anhydrous MeOH and sodium borohydride (0.85 g, 22.5 mmol) is added portionwise. The mixture is stirred at room temperature for 10 min, then quenched with water. The mixture is diluted with Et₂O and the layers separated. The organic layer is washed with H₂O, then dried over MgSO₄, filtered and concentrated to yield the title compound (2.23 g, 9.66 mmol) which is used in the subsequent step without further purification. ¹H NMR (CDCl₃, 300MHz) δ 6.95 (d, 1H), 6.90 (m, 2H), 6.86 (d, 1H), 4.82 (s, 2H), 1.88 (bs, 1H).

B. 5-Bromomethyl-5'-chloro-[2,2']bithiophenyl.

To a solution of (5'-chloro-[2,2']bithiophenyl-5-yl)-methanol (2.23 g, 9.66 mmol) in 65 mL of CH₂Cl₂ is added bromotrimethylsilane (3.82 mL, 29.0 mmol). After 4 h, the solution is concentrated in vacuo. The crude product is stirred in hot hexanes and filtered. The filtrate is concentrated and the title compound (1.67 g, 5.69 mmol) is obtained as a green solid. ¹H NMR (CDCl₃, 300MHz) δ 7.00 (d, 1H), 6.94 (m, 2H), 6.85 (d, 2H), 4.71 (s, 2H).

EXAMPLE 7. 7-Bromomethyl-4-chloroquinazoline.

A. 7-Methyl-3H-quinazolin-4-one.

A solution of 2-amino-4-methylbenzoic acid (31.6 g, 206 mmol) in formamide (60mL) is heated to 130°C for 1 hour, then at 175°C for 3 hours. The solution is poured into 500 mL of ice

water. The resulting solid is collected by filtration and further dried under reduced pressure. The title compound (26.2 g, 170 mmol) is obtained as a white solid. MS (EI): m/z 159 (M+).

B. 4-Chloro-7-methyl-quinazoline.

To a solution of 7-methyl-3H-quinazolin-4-one (10.6 g, 69 mmol) in toluene (350 mL) is added triethylamine (17.5 g, 173 mmol) followed by phosphorous oxychloride (12.3 g, 80 mmol). The resulting solution is heated to 80°C. After 4 hours, the solution is cooled to ambient temperature. The reaction mixture is poured into 500 mL of water. The layers are separated and the organic layer is washed with H₂O, saturated NaHCO₃, and saturated NaCl, dried over MgSO₄, filtered and concentrated. The resulting crude product is purified by recrystallization from EtOAc. The title compound is obtained as a white solid (10 g, 56 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 9.02 (s, 1H), 8.16 (d, 1H), 7.87 (s, 1H), 7.55 (d, 1H), 2.62 (s, 3H).

C. 7-Bromomethyl-4-chloroquinazoline.

To a solution of 4-chloro-7-methylquinazoline (7.0 g, 39 mmol) in carbon tetrachloride (140 mL) is added N-bromosuccinimide (8.0 g, 45 mmol), and benzoyl peroxide (0.8 g, 3.3 mmol). The solution is refluxed for 8 hours. After this time, the solution is filtered. The filtrate is concentrated and the residue is stirred with ether to give the title compound as an off-white solid (5.1 g, 20 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 9.10 (s, 1H), 8.30 (d, 1H), 8.10 (s, 1H), 7.82 (d, 1H), 4.68 (s, 2H). MS (EI): m/z 237 (M+).

EXAMPLE 8. 3-Bromomethyl-7-chloro-1H-quinolin-2-one.

A. N-(3-Chlorophenyl)-2-methyl-3-phenylacrylamide.

To a solution of 3-chloroaniline (0.98 mL, 9.3 mmol) in CH₂Cl₂ (25 mL) at 0°C is added pyridine (0.78 mL, 9.5 mmol). To the resulting solution is added dropwise a solution of α -methyl cinnamic acid chloride (1.6 g, 9.3 mmol) in CH₂Cl₂ (8 mL). After 3 hours, the solution is concentrated. The crude product is purified by column chromatography eluting with 5% EtOAc/hexanes to 10% EtOAc/hexanes. The title compound is obtained as a solid (2.5 g, 9.2 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 7.95 (m, 1H), 7.73 (s, 1H), 7.46 (m, 1H), 7.33 (m, 6H), 7.22 (m, 1H), 7.03 (m, 1H), 2.13 (s, 3H).

B. 7-Chloro-3-methyl-1H-quinolin-2-one.

To a solution of N-(3-chlorophenyl)-2-methyl-3-phenylacrylamide (2.5 g, 9.2 mmol) in chlorobenzene (50 mL) is added AlCl₃ (6.2 g, 46 mmol). The solution is heated to 120°C. After 4 hours, the solution is poured onto ice. The solution is filtered. The organic layer is washed with 1N HCl, H₂O and saturated NaCl. The crude product is purified by column chromatography eluting with 2% MeOH/CH₂Cl₂. The title compound is obtained as a white solid

(1.5 g, 7.74 mmol). ¹H NMR (d6-DMSO, 300 MHz) δ 11.82 (bs, 1H), 7.73 (s, 1H), 7.52 (m, 1H), 7.21 (m, 2H), 2.08 (s, 3H).

C. 3-Bromomethyl-7-chloro-1H-quinolin-2-one.

The title compound is prepared as described in Example 7, Part C, substituting 7-chloro-3-methyl-1H-quinoline-2-one for 7-methyl-4-chloroquinazoline. The title compound is obtained as a white solid. ¹H NMR (d6-DMSO, 300 MHz) δ 12.00 (bs, 1H), 8.17 (s, 1H), 7.72 (d, 1H), 7.29 (m, 2H), 4.58 (s, 2H).

EXAMPLE 4. 6-Bromomethyl-2-chloro-quinoline.

A. 6-Methyl-1H-quinolin-2-one.

The title compound is prepared from p-toluidine and cinnamoyl chloride according to the procedure described in Synthesis 1975, 739. The crude product obtained is triturated in Et₂O/hexanes and filtered to give the title compound as a beige solid. ¹H NMR (DMSO-d₆, 300 MHz) δ 11.60 (bs, 1H), 7.82 (d, 1H), 7.41 (s, 1H), 7.30 (d, 1H), 7.18 (d, 1H), 6.45 (d, 1H), 2.30 (s, 3H).

B. 2-Chloro-6-methylquinoline.

6-Methyl-1H-isoquinolin-2-one (14.6 g, 91.7 mmol) in phosphorus oxychloride (160 mL) is heated at 60°C for 17 hours. The mixture is cooled to room temperature, then concentrated to a beige residue. The residue is diluted with ice water and the pH is adjusted to about 8 by slow addition of 10 N NaOH. The crude product is precipitated out during neutralization of the aqueous solution and the solid is filtered, washed with water and dried. The solid is recrystallize from MeOH to afford the title compound (12.0 g, 67.5 mmol) as a beige solid. ¹H NMR (CDCl₃, 300 MHz) δ 8.02 (d, 1H), 7.92 (d, 1H), 7.60 (s, 1H), 7.58 (d, 1H), 7.33 (d, 1H), 2.53 (s, 3H).

C. 6-Bromomethyl-2-chloro-quinoline.

N-Bromosuccinimide (12.9 g, 72.5 mmol) and benzoyl peroxide (0.33 g, 1.30 mmol) are added to a solution of 2-chloro-6-methyl-quinoline (12.0 g, 67.5 mmol) in carbon tetrachloride (300 mL). The mixture is heated at reflux for 6 hours. At this time, the resulting mixture is cooled to room temperature, filtered, washed with CH₂Cl₂ and concentrated in vacuo. The crude residue is recrystallized from 50% EtOAc/hexanes to yield the title compound (8.80 g, 34.3 mmol) as a beige crystalline solid. ¹H NMR (CDCl₃, 300 MHz) δ 8.08 (d, 1H), 8.02 (d, 1H), 7.83 (s, 1H), 7.77 (dd, 1H), 7.40 (d, 1H), 4.65 (s, 2H). MS (EI): m/z 256, 258 (M⁺), Cl pattern.

EXAMPLE 10. 3-Bromomethyl-1,7-dichloro-2H-isoquinoline.

A. 3-(4-Chlorophenyl)-2-methyl-acryloyl azide.

To a solution of 3-(4-chlorophenyl)-2-methyl-acrylic acid (11.2 g, 57 mmol) in 500 mL of acetone at 0°C is added triethyl amine (9.6 mL, 68 mmol) followed by ethyl chloroformate (6.2 mL, 63 mmol). The solution is allowed to warm to ambient temperatures. After 2 h, sodium azide (5.6 g, 86 mmol) in 35 mL of H₂O is added. After addition, the solution is stirred for 2 hours. The solution is diluted with H₂O (100 mL). The resulting solid is collected by filtration giving the title compound as a white solid (11.1 g, 50mmol). ¹H NMR (CDCl₃, 300 MHz) δ 7.67 (s, 1H), 3.38 (m, 4H), 2.10 (s, 3H).

B. 7-Chloro-3-methyl-2H-isoquinoline-1-one.

3-(4-Chlorophenyl)-2-methyl-acryloyl azide (11.0 g, 50 mmol) is dissolved in 80 mL of diphenyl ether. The solution is added dropwise to a solution of tributyl amine (11.8 mL, 50mmol) in 170 mL of diphenyl ether at 210°C. After 4 hours., the solution is cooled 50°C and diluted with 1.5 L of hexanes. The resulting solid is collected by filtration giving the title compound as a white solid (7.2 g, 37 mmol). ¹H NMR (d6-DMSO, 300 MHz) δ 11.4 (bs, 1H), 8.02 (s, 1H), 7.67 (d, 1H), 7.55 (d, 1H), 6.34 (s, 1H), 2.18 (s, 3H).

C. 1,7-Dichloro-3-methyl-isoquinoline.

A solution of 7-chloro-3-methyl-2H-isoquinoline-1-one (7.1 g, 36.7 mmol) in 100 mL of phosphorous oxychloride is heated to 100°C. After 5 h, the solution is concentrated to dryness. The residue is dissolved in CH₂Cl₂. The solution is washed with H₂O. The organic layer is dried over MgSO₄, filtered and concentrated. The crude product is purified by column chromatography eluting with a gradient of 3%EtOAc/hexanes to 5% EtOAc/hexanes. The title compound is obtained as a white solid (6.0g, 28 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 8.23 (s, 1H), 7.68 (m, 1H), 7.63 (m, 1H), 7.40 (s, 1H), 2.64 (s, 3H).

D. 3-Bromomethyl-1,7-dichloro-2H-isoquinoline.

The title compound is prepared as described in Example 7, part C, substituting 1,7-dichloro-3-methyl-isoquinoline for 4-chloro-7-methylquinazoline. ¹H NMR (CDCl₃, 300 MHz) δ 8.29 (s, 1H), 7.82 (m, 1H), 7.76 (m, 2H), 4.68 (s, 2H).

EXAMPLE 11. 3-Bromomethyl-7-chloroisoquinoline.

A. 7-Chloro-3-methyl-isoquinoline.

To a solution of 1,7-dichloro-3-methyl-isoquinoline (0.50 g, 2.36 mmol), Example 10, part C, in 5.5 mL of 9:1 acetic acid:H₂O at 75°C is added zinc (0.23 g, 3.54 mmol) After 75 minutes, the solution is cooled to ambient temperatures. The solution is diluted with a 4:1 EtOAc:CH₂Cl₂ solution. To the solution is added 100mL of a 1N NaOH solution. The aqueous solution is extracted with 4:1 EtOAc:CH₂Cl₂. The combined organic layers are washed with a saturated NaCl solution. The organic layer is dried over MgSO₄, filtered and concentrated. The

crude product is purified by column chromatography eluting with a gradient of 5%EtOAc/hexanes to 15% EtOAc/hexanes. The title compound is obtained as a white solid (0.36 g, 1.97 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 9.09 (s, 1H), 7.89 (s, 1H), 7.61 (d, 1H), 7.55 (d, 1H), 7.44 (s, 1H) 2.68 (s, 3H). MS (EI): m/z 177, 179 (M⁺), CI pattern.

5 B. 3-Bromomethyl-7-chloroisoquinoline.

The title compound is prepared as described in Example 7, part C, substituting 7-chloro-3-methyl-isoquinoline for 4-chloro-7-methylquinazoline. ¹H NMR (CDCl₃, 300 MHz) δ 9.18 (s, 1H), 7.97 (s, 1H), 7.75 (m, 2H), 7.67 (m, 1H), 4.71 (s, 2H).

10 EXAMPLE 12. 2-Bromomethyl-6-chloronaphthalene.

A. 6-Chloro-3,4-dihydro-1H-naphthalene-2-one.

To a solution of (4-chlorophenyl)-acetyl chloride (17.3 g, 92 mmol) in 50 mL of CH₂Cl₂ at -20°C is added a solution of AlCl₃ (24.4 g, 184 mmol) in 200 mL CH₂Cl₂ dropwise. After 20 minutes, ethylene (g) is bubbled through the solution for 30 minutes. The solution is stirred at -10°C for 15 minutes. The reaction mixture is poured into 300 g of ice. The layers are separated. The organic layer is washed with H₂O, saturated NaHCO₃ and saturated NaCl. The organic layer is dried over MgSO₄, filtered and concentrated. The resulting solid is triturated with pentane (2x20mL). The solid is then dried to give the title compound as a solid (15.2 g, 84.2 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 7.28 (m, 2H), 7.06 (m, 1H), 3.52 (s, 2H), 3.04 (m, 2H), 2.56 (m, 2H).

B. 6-Chloro-2-methyl-1,2,3,4-tetrahydronaphthalene-2-ol.

To a solution of TiCl₄ (95 mL, 1M in toluene) at -45°C is added a solution of CH₃MgBr (4.2 mL 3M in THF). The solution is stirred for 20 minutes. After this time, 6-chloro-3,4-dihydro-1H-naphthalene-2-one (11.3 g, 63 mmol) in 80 mL of CH₂Cl₂ is added dropwise over 15 minutes. The reaction is stirred for an additional 15 min at -45°C. The solution is warmed to 0°C. After 2 h, the solution is diluted with H₂O and CH₂Cl₂. The organic layer is dried over MgSO₄, filtered and concentrated. The title compound is obtained as an oil (11.3 g, 57.5 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 7.10 (m, 2H), 6.97 (m, 1H), 3.02 (m, 2H), 2.80 (s, 3H), 1.85 (m, 2H), 1.80 (m, 2H).

30 C. 2-Chloro-6-methyl naphthalene.

A solution of 6-chloro-2-methyl-1,2,3,4-tetrahydronaphthalene-2-ol (11.3 g, 57.5 mmol) and Ph₃COH (16.5 g, 63 mmol) in 80 mL of TFA is stirred for 2.5 days. After this time, the solution is concentrated to dryness. The residue is dissolved in CH₂Cl₂. The organic layer is washed with H₂O, saturated NaHCO₃, and saturated NaCl. The organic layer is dried over MgSO₄, filtered and concentrated. The crude product is purified by column chromatography

eluting with hexanes. The title compound is obtained as a white solid (4.05 g, 22.9 mmol). ^1H NMR (CDCl_3 , 300 MHz) δ 7.78 (s, 1H), 7.69 (m, 2H), 7.58 (s, 1H), 7.50 (m, 2H), 2.49 (s, 3H).

D. 2-Bromomethyl-6-chloronaphthalene.

The title compound is prepared as described in Example 7, part C, substituting 2-chloro-6-methyl naphthalene for 4-chloro-7-methylquinazoline. ^1H NMR (CDCl_3 , 300 MHz) δ 7.82 (m, 2H), 7.78 (s, 1H), 7.76 (m, 2H), 7.52 (d, 1H), 7.42 (d, 1H), 4.62 (s, 2H).

EXAMPLE 13. 2-(Benzhydrylidene-amino)-4-bromomethyl-benzonitrile.

A. 2-(Benzhydrylidene-amino)-4-methyl-benzonitrile.

To a solution of 2-amino-4-methyl benzonitrile (20 g, 151 mmol) in 1000mL of dichloroethane is added benzophenone imine (30g, 166mmol). The solution is refluxed for 48 hours. After this time, the solution is cooled to ambient temperatures. The solution is washed with sat. NaHCO_3 , water and sat. NaCl . The organic layer is dried over MgSO_4 , filtered and concentrated under vacuum. The product is further purified by recrystallization from t-butyl ether. The title compound (25.5g, 118mmol) is obtained as a yellow solid. ^1H NMR (CDCl_3 , 300MHz) δ 7.88 (m, 2H), 7.42 (m, 3H), 7.32 (m, 7H), 6.79 (d, 1H), 6.58 (s, 1H), 2.23 (s, 3H).

B. 2-(Benzhydrylidene-amino)-4-bromomethyl-benzonitrile.

To a solution of 2-(benzhydrylidene-amino)-4-methyl-benzonitrile (11.2g, 37.8mmol) in 500mL of CCl_4 is added N-bromosuccinimide (7.06g, 39.7mmol), and benzoyl peroxide (0.92g, 3.8mmol). The solution is heated to reflux for 16 hours. After this time, the solution is filtered and the organic solution is concentrated under vacuum. The residue is purified by column chromatography eluting with a gradient of 20%t-butyl ether/hexanes to 25% t-butyl ether/hexanes. The product is obtained as an oil containing a mixture of the desired monobromide, dibromide and unreacted starting material. The mixture is assayed by proton NMR and is found to have a purity between 60-75%. ^1H NMR (CDCl_3 , 300MHz) δ 7.82 (m, 2H), 7.42 (m, 9H), 6.92 (d, 1H), 6.81 (s, 1H), 4.29 (s, 2H).

EXAMPLE 14. 7-Bromomethyl-4-chloroquinoline.

A. 7-Methyloxycarbonyl-4-chloroquinoline.

4-Chloro-7-trifluoromethylquinoline (5.0 g, 21.6 mmol) in 100 mL 80% H_2SO_4 is heated to 200°C for 24 hours in a sealed tube. The solution is cooled, poured into water and neutralized with sodium hydroxide to pH ~ 3-4. The precipitated solid is collected, washed with water and dissolved in 2 N sodium hydroxide. The aqueous solution is washed with ethyl acetate then acidified to pH~3-4. The precipitate is collected, washed with water and dried in a vacuum oven overnight to yield 7-carboxy-4-chloroquinoline as a solid (5.1 g, 24.6 mmol). A portion of this material (2.0 g, 9.6 mmol) is treated with anhydrous THF (200 mL) and DMF (2

mL) and 2 M oxalyl chloride in methylene chloride (14.5 mL, 29 mmol). The resulting suspension is stirred at room temperature for 2 h then treated with methanol (10 mL). After stirring 30 minutes the solution is concentrated and the residue is taken up in methylene chloride. The solution is washed with saturated sodium bicarbonate and dried (sodium sulfate) and concentrated to yield the title compound as a solid (2.1 g, 9.5 mmol). MS m/z: M^+ = 221; ^1H NMR (CDCl_3 , 300 MHz) δ 8.6 (s, 1H), 8.2 (s, 1H), 7.9 (d, 1H), 7.65 (d, 1H), 7.45 (s, 1H), 3.95 (s, 3H).

B. 7-Hydroxymethyl-4-chloroquinoline.

7-Methyloxycarbonyl-4-chloroquinoline (2.1 g, 9.5 mmol) is dissolved in anhydrous THF (25 mL) and anhydrous ether (200 mL). The solution is cooled in a dry ice/acetone bath and treated 1M lithium aluminum hydride in THF (11.0 mL, 11 mmol). The solution is warmed (approximately -45°C) for 20 minutes and quenched with ethyl acetate. The solution is diluted with ether (100 mL) and treated with water (36 mL), 15% NaOH (36 mL) and water (36 mL) in succession. The mixture is filtered and evaporated to yield the title compound as a residue (2.0 g, 9.7 mmol) which is dried under vacuum and used without further purification. MS m/z: M^+ = 193; ^1H NMR (CDCl_3 , 300 MHz) δ 8.65 (d, 1H), 8.15 (d, 1H), 8.0 (d, 1H), 7.6 (d, 1H), 7.45 (d, 1H), 4.8 (s, 2H).

C. 7-Bromomethyl-4-chloroquinoline.

7-Hydroxymethyl-4-chloroquinoline (0.2 g, 0.97 mmol) is treated with 48 % HBr and heated to 120°C for 1 hours. The resulting solution is cooled with ice, diluted with water and treated with ethyl acetate and sodium bicarbonate until basic to pH paper. The layers are separated and the organic layer is washed with water, dried (Na_2SO_4) and concentrated to give 7-bromomethyl-4-chloroquinoline (0.23 g, 0.9 mmol). MS m/z: M^+ = 255; ^1H NMR (CDCl_3 , 300 MHz) δ 8.75 (d, 1H), 8.25 (d, 1H), 8.1 (s, 1H), 7.7 (d, 1H), 7.5 (d, 1H), 4.7 (s, 2H).

EXAMPLE 15. 7-Bromomethyl-4-chlorocinnoline.

A. 4-methyl-2-nitrophenylethanone.

4-Fluoro-3-nitrotoluene (7.5 g, 48.4 mmol) is treated with a solution of nitroethane (15.2 mL, 200 mmol) in ethyl acetate (100 mL) and DBU (21 mL, 145 mmol) and stirred overnight at ambient temperature. The solution is concentrated under vacuum, diluted with methanol, treated with 30% H_2O_2 (25 mL) and 10% sodium bicarbonate (25 mL) and stirred overnight at ambient temperature. The reaction mixture is concentrated in vacuo, acidified with 5% HCl and extracted with methylene chloride. The organic layer is dried (sodium sulfate) and chromatographed (35% ethyl acetate/hexane) to give the title compound (7.2 g, 40.2 mmol).

MS m/z: M^+ = 279; ^1H NMR (CDCl_3 , 300MHz) δ 7.8 (s, 1H), 7.48 (d, 1H), 7.32 (d, 1H), 2.5 (s, 3H), 2.4 (s, 3H).

B. 2-Amino-4-methylphenylethanone.

A solution of 4-methyl-2-nitrophenylethanone (5.0 g, 28 mmol) in methanol (100 mL) is
5 treated with ammonium formate (9.6 g, 140 mmol) and 5% palladium on carbon (1.5 g). The
mixture is heated to 60°C for 6 h then stirred at ambient temperature for 16 hours. The
reaction mixture is filtered through Celite and the filtrate is concentrated in vacuo. The
concentrate is treated with sodium bicarbonate and partitioned between water and ethyl
acetate. The organic layer is separated, dried with sodium sulfate and concentrated to give
10 crude title compound (4.5 g, 30.2 mmol) which is used without further purification. MS m/z: M^+ =
149; ^1H NMR (CDCl_3 , 300MHz) δ 8.05 (d, 1H), 7.4 (d, 1H), 7.25 (s, 1H), 2.8 (s, 3H), 2.45 (s,
3H).

C. 7-Methyl-1-H-cinnolin-4-one.

A solution of 2-amino-4-methylphenylethanone (5.0 g, 33.6 mmol) in concentrated HCl
15 (100 mL) is treated, in portions, with a solution of sodium nitrite (5.7 g, 82.6 mmol) in water (~
10 mL). The resulting solution is stirred at 60°C for 2 hr, cooled to ambient temperature and
diluted with a saturated solution of sodium acetate (~ 200 mL). Solid sodium acetate is added
portionwise until the solution tested basic to pH paper. Upon stirring, the title compound
precipitated as a white solid which is collected and air dried (2.3 g, 14.3 mmol). MS m/z: $[M+H]^+$
20 = 161; ^1H NMR (CDCl_3 , 300MHz) δ 8.1 (d, 1H), 7.85 (s, 1H), 7.45 (s, 1H), 7.3 (d, 1H), 2.55 (s,
3H).

D. 4-Chloro-7-methylcinnoline.

7-Methyl-1-H-cinnolin-4-one (1.3 g, 8.1 mmol) is treated with about 80 mL of
chlorobenzene and heated until the solid dissolves. The resulting solution is cooled and treated
25 with pyridine (0.16 mL, 2 mmol) and POCl_3 (1.13 mL, 12.2 mmol). The solution is heated to
reflux for 1 h then concentrated to dryness. The residue is chromatographed (20 % ethyl
acetate/hexane) to yield the title compound as a tan solid (~ 1 g, 5.6 mmol). MS m/z (M^+ =178);
 ^1H NMR (CDCl_3 , 300MHz) δ 9.3 (s, 1H), 8.35 (s, 1H), 8.1 (d, 1H), 7.7 (d, 1H), 2.68 (s, 3H).

E. 7-Bromomethyl-4-chlorocinnoline.

30 A solution of 4-chloro-7-methylcinnoline (0.6 g, 3.37 mmol) in carbon tetrachloride (30
mL) is treated with N-bromosuccinimide (0.64 g, 3.4 mmol) and a catalytic amount of 70 %
benzoyl peroxide (0.22 g, 0.63 mmol). The solution is heated to 80 °C overnight, then filtered.
The filtrate is concentrated in vacuo and the resulting residue is chromatographed (20 % ethyl
acetate/ methyl chloride) to give the title compound (0.3 g, 1.2 mmol) and some unreacted

starting material (0.1 g, 0.56 mmol). MS m/z : $[M+H]^+ = 257$; 1H NMR ($CDCl_3$, 300MHz) δ 9.35 (s, 1H), 8.55 (s, 1H), 8.2 (d, 1H), 8.85 (d, 1H), 4.75 (s, 2H).

EXAMPLE 16. 6-Bromomethyl-3-chloro-1-(toluene-4-sulfonyl)-1H-indole.

5 A. 1H-Indole-6-carboxylic acid methyl ester.

To a solution of 6-indole carboxylic acid (0.91 g, 5.67 mmol) in 33 mL of 2:1 THF/MeOH is added (trimethylsilyl)diazomethane (5.0 mL of a 2.0M solution in hexanes, 10.0 mmol). The mixture is stirred for 3 h and concentrated in vacuo to give the title compound (0.87 g, 4.97 mmol). The crude product is used in the next step without further purification. 1H NMR ($CDCl_3$, 300 MHz) δ 8.70 (bs, 1H), 8.20 (s, 1H), 7.82 (dd, 1H), 7.67 (d, 1H), 7.45 (m, 1H), 6.60 (m, 1H), 3.95 (s, 3H).

B. 3-Chloro-1H-indole-6-carboxylic acid methyl ester.

To a solution of 1H-indole-6-carboxylic acid methyl ester (5.86 g, 33.5 mmol) in 30 mL of CH_2Cl_2 is added N-chlorosuccinimide (0.58, 4.33 mmol) portionwise over 1.5 hours. The mixture is stirred for 2 h, then diluted with water. The layers are separated and the organic phase is washed with water and saturated NaCl solution. The organic layer is dried over $MgSO_4$, filtered and concentrated in vacuo to give the title compound (5.74 g, 27.3 mmol). The crude product is used in the next step without further purification. 1H NMR ($CDCl_3$, 300 MHz) δ 8.46 (bs, 1H), 8.19 (s, 1H), 7.90 (dd, 1H), 7.69 (d, 1H), 7.36 (d, 1H), 3.97 (s, 3H).

20 C. 3-Chloro-1-(toluene-4-sulfonyl)-1H-Indole-6-carboxylic acid methyl ester.

To a solution of 3-chloro-1H-indole-6-carboxylic acid methyl ester (3.00 g, 17.1 mmol) in 40 mL of THF at $-78^\circ C$ is added LDA (8.55 mL of a 2.0M solution in hexanes, 17.1 mmol) dropwise. The solution is stirred at $-78^\circ C$ for 30 minutes p-Toluenesulfonyl chloride (3.43 g, 18.0 mmol) in 15 mL of THF is added dropwise and the resulting solution is stirred at $-78^\circ C$ for 3 hours. The mixture is warmed to $0^\circ C$, quenched with saturated $NaHCO_3$ solution and diluted with H_2O and Et_2O . The layers are separated. The organic phase is washed with saturated $NaHCO_3$ solution, H_2O and saturated NaCl solution, then dried over $MgSO_4$, filtered and concentrated. The crude residue is purified via flash column chromatography eluting with a gradient of 10% EtOAc/hexanes to 30% EtOAc/hexanes to provide the title compound (3.64 g, 10.0 mmol). 1H NMR ($CDCl_3$, 300MHz) δ 8.70 (s, 1H), 8.01 (dd, 1H), 7.80 (d, 2H), 7.70 (s, 1H), 7.60 (d, 1H), 7.38 (m, 2H), 4.00 (s, 3H), 2.49 (s, 3H).

D. [3-Chloro-1-(toluene-1-sulfonyl)-1H-indol-6-yl]-methanol.

To a solution of 3-chloro-1-(toluene-4-sulfonyl)-1H-Indole-6-carboxylic acid methyl ester (3.10 g, 8.53 mmol) in 50 mL of toluene at $-78^\circ C$ is added DIBAL (13.8 mL of a 1.5M solution in toluene, 20.8 mmol) dropwise. The mixture is stirred at $-78^\circ C$ for 2 h, then warmed to room

temperature and stirred for 2 hours. The reaction mixture is quenched by the addition of MeOH and washed with saturated disodium tartrate solution. The aqueous layer is extracted with Et₂O. The combined organics are washed with saturated disodium tartrate solution, water and saturated NaCl solution. The organic phase is then dried over anhydrous MgSO₄, filtered and concentrated to give the title compound (2.88 g). The crude product is used in the next step without further purification. ¹H NMR (CDCl₃, 300 MHz) δ 8.01 (s, 1H), 7.79 (d, 2H), 7.56 (s, 1H), 7.53 (d, 1H), 7.31 (d, 1H), 7.25 (d, 2H), 4.84 (s, 2H), 2.37 (s, 3H), 1.88 (bs, 1H).

E. 6-Bromomethyl-3-chloro-1-(toluene-4-sulfonyl)-1H-indole.

To a solution of [3-chloro-1-(toluene-1-sulfonyl)-1H-indol-6-yl]-methanol (0.45 g, 1.34 mmol) in 13 mL of Et₂O at 0°C is added phosphorous tribromide (0.04 mL, 0.40 mmol). The mixture is stirred at 0°C for 15 min, then at room temperature for 2 hours. The mixture is quenched by the addition of water/ice and diluted with Et₂O. The layers are separated and the organic phase is washed with saturated NaHCO₃ solution, water and saturated NaCl solution. The organic layer is dried over anhydrous MgSO₄, filtered and concentrated to provide the title compound (0.47 g, 1.18 mmol) as an oil. The crude product is used in the subsequent step without further purification. ¹H NMR (CDCl₃, 300 MHz) δ 8.09 (s, 1H), 7.79 (d, 2H), 7.59 (s, 1H), 7.50 (d, 1H), 7.35 (d, 1H), 7.27 (m, 2H), 4.66 (s, 2H), 2.39 (s, 3H).

EXAMPLE 17. 2-(3-Bromo-(E)-propenyl)-5-chloro-thiophene.

A. 3-(5-Chloro-thiophen-2-yl)-(E)-acrylic acid methyl ester.

To a solution of 5-chloro-2-thiophene-carboxaldehyde (5.10 g, 34.8 mmol) in 100 mL of dry CH₂Cl₂ is added methyl (triphenylphosphoranylidene)acetate (11.8 g, 35.3 mmol). The resulting brown-green mixture is stirred for 19 h at room temperature. The mixture is filtered through a Celite pad, concentrated in vacuo and triturated with hexane. The white precipitate (triphenylphosphine oxide) is filtered off and the filtrate is concentrated. The crude residue is purified via flash column chromatography eluting with a gradient of 5% EtOAc/hexanes to 10% EtOAc/hexanes to provide the title compound (6.20 g, 30.6 mmol) as a yellow solid. ¹H NMR (CDCl₃, 300MHz) δ 7.65 (d, 1H), 7.05 (d, 1H), 6.89 (d, 1H), 6.10 (d, 1H), 3.80 (s, 3H).

B. 3-(5-Chloro-thiophen-2-yl)-prop-2-(E)-en-1-ol.

To a solution of 3-(5-chloro-thiophen-2-yl)-(E)-acrylic acid methyl ester (5.00 g, 24.7 mmol) in 80 mL of CH₂Cl₂ at 0°C is added slowly a solution of DIBAL (36.2 mL of a 1.5M solution in toluene, 54.3 mmol). The mixture is stirred at 0°C for 15 min, then quenched by the addition of 6 mL of MeOH. The mixture is allowed to warm to room temperature, diluted with water/ice and stirred for 15 minutes. The mixture is filtered through a pad of Celite and washed with CH₂Cl₂. The layers are separated and the aqueous layer is extracted with CH₂Cl₂. The

combined organics are washed with saturated NaCl solution, dried over anhydrous Na₂SO₄, filtered and concentrated. The residue is purified via flash column chromatography eluting with a gradient of 15% EtOAc/hexanes to 25% EtOAc/hexanes to afford the title compound (4.18 g, 23.9 mmol) as an oil. ¹H NMR (CDCl₃, 300 MHz) δ 6.77 (d, 1H), 6.71 (d, 1H), 6.60 (d, 1H), 6.10 (m, 1H), 4.30 (d, 2H), 1.79 (bs, 1H).

C. 2-(3-Bromo-(E)-propenyl)-5-chloro-thiophene.

To a solution of 3-(5-chloro-thiophen-2-yl)-prop-2-(E)-en-1-ol (4.18 g, 23.9 mmol) in 140 mL of Et₂O at 0°C is added phosphorous tribromide (1.34 mL, 14.3 mmol) in 10 mL of Et₂O.

The mixture is stirred at 0°C for 45 min, then at room temperature for 1.5 hours. The mixture is quenched by the addition of water/ice and diluted with Et₂O. The layers are separated and the organic phase is washed with water until neutral (3x) and once with saturated NaCl solution.

The organic layer is dried over anhydrous MgSO₄, filtered and concentrated to provide the title compound (5.46 g, 23.0 mmol) as an oil. The crude material solidified upon storage in the freezer and can be used in the subsequent step without further purification. ¹H NMR (CDCl₃,

300 MHz) δ 6.80 (m, 2H), 6.65 (d, 1H), 6.10 (m, 1H), 4.10 (d, 2H).

EXAMPLE 18. 3-(4-Bromo-furan-2-yl)-(E)-propenal.

To a solution of 4-bromo-2-furfuraldehyde (0.5 g, 2.86 mmol) in 30 mL of dry CH₂Cl₂ is added (triphenylphosphoranylidene)acetaldehyde (0.87 g, 2.86 mmol). The resulting mixture is stirred for 16 h at room temperature. The crude mixture is concentrated in vacuo and the residue is purified via flash column chromatography eluting with CH₂Cl₂ to provide the title compound (0.15 g, 0.75 mmol) as a white solid. ¹H NMR (CDCl₃, 300 MHz) δ 9.62(d, 1H), 7.59 (s, 1H), 7.18 (d, 1H), 6.81 (s, 1H), 6.60 (m, 1H).

EXAMPLE 19. Acetic acid 3-(6-methoxy-pyridin-3-yl)-(E)-allyl ester.

To a solution of 3-(6-methoxy-pyridin-3-yl)-prop-2-(E)-en-1-ol (0.39 g, 2.36 mmol, prepared as described in EXAMPLE 17 from 6-methoxy-pyridine-3-carbaldehyde (J. Org. Chem. 1990, 72)) in 8 mL of CH₂Cl₂ at 0°C is added triethylamine (0.66 mL, 4.72 mmol), DMAP (0.05 g, 0.40 mmol) and Ac₂O (0.33 mL, 3.54 mmol). The mixture is stirred at 0°C for 45 min, then at room temperature for 16 hours. The mixture is diluted with Et₂O and washed with 1N HCl, water, saturated NaHCO₃ solution and saturated NaCl solution. The organic layer is dried over anhydrous MgSO₄, filtered and concentrated. The residue is purified via flash column chromatography eluting with a gradient of 10% EtOAc/hexanes to 20% EtOAc/hexanes to afford the title compound (0.25 g, 1.21 mmol) as an oil. ¹H NMR (CDCl₃, 300 MHz) δ 8.12 (d,

1H), 7.68 (dd, 1H), 6.72 (d, 1H), 6.60 (d, 1H), 6.18 (dt, 1H), 4.73 (d, 2H), 3.95 (s, 3H), 2.10 (s, 3H).

EXAMPLE 20. 2-(3-Bromo-prop-1-ynyl)-5-chloro-thiophene.

5 A. 3-(5-Chloro-thiophen-2-yl)-prop-2-yn-1-ol.

Nitrogen (g) is bubbled through a solution of 5-bromo-2-chloro-thiophene (1.00 g, 5.06 mmol) in 8 mL of piperidine. After 5 min, propargyl alcohol (0.32 mL, 5.56 mmol), tetrakis(triphenylphosphine) palladium(0) (0.06 g) and CuI (catalytic amount) are added to the solution. The mixture is heated at 80°C for 1 h in a sealed glass vessel. At this time, the
10 mixture is cooled and diluted with EtOAc/Et₂O. The organic layer is washed 3N HCl, water, saturated NaHCO₃ solution and saturated NaCl solution. The organic layer is dried, filtered and concentrated. The crude residue is purified via flash column chromatography eluting with a gradient of 10% EtOAc/hexanes to 20% EtOAc/hexanes to give the title compound (0.8 g, 0.46 mmol) as an oil. ¹H NMR (DMSO-d₆, 300 MHz) δ 6.99 (d, 1H), 6.80 (d, 1H), 4.49 (s, 2H), 1.90
15 (bs, 1H). EI MS, [M]⁺=172, 174 (CI pattern).

B. 2-(3-Bromo-prop-1-ynyl)-5-chloro-thiophene.

The title compound is prepared as described in EXAMPLE 17, Part C, using 3-(5-chloro-thiophen-2-yl)-prop-2-yn-1-ol in place of 3-(5-chloro-thiophen-2-yl)-prop-2-(E)-en-1-ol. The crude product is used in the subsequent step without further purification.

20 ¹H NMR (CDCl₃, 300 MHz) δ 7.04 (d, 1H), 6.80 (d, 1H), 4.98 (d, 2H).

EXAMPLE 21. 2-Bromomethyl-5-chloro-indole-1-carboxylic acid tert-butyl ester.

A. 5-Chloro-2-methyl-indole-1-carboxylic acid tert-butyl ester.

A solution containing 5-chloro-2-methylindole (4.0 g, 24.1 mmol) and DMAP (295 mg, 2.42 mmol) in anhydrous THF (100 mL) is cooled to 0°C. A solution containing (Boc)₂O (5.27 g, 24.1 mmol) in anhydrous THF (100 mL) is then added over a 20 min period. The reaction mixture is stirred for 2 h at 0°C and then at ambient temperature for 16 hours. The reaction mixture is concentrated and the crude residue is purified by flash silica gel chromatography (2% EtOAc/hexane to 5% EtOAc/hexane) to provide 5.2 g (81%) of title compound as a pale yellow
30 solid. ¹H NMR (300 MHz, CDCl₃) δ 1.67 (s, 9H), 2.57 (s, 3H), 6.24 (t, J = 0.9 Hz, 1H), 7.16 (dd, J = 8.8, 2.1 Hz, 1H), 7.38 (d, J = 2.1 Hz, 1H), 8.01 (d, J = 8.8 Hz, 1H) ppm; MS (EI): m/z 265 (M⁺).

B. 2-Bromomethyl-5-chloro-indole-1-carboxylic acid tert-butyl ester.

A solution containing 5-chloro-2-methyl-indole-1-carboxylic acid tert-butyl ester (3.0 g, 11.3 mmol), NBS (1.33 g, 11.3 mmol), and benzoyl peroxide (0.4 g, 1.13 mmol) in CCl₄ (100
35

mL) is heated at 80°C for 3 hours. An additional portion of NBS (0.65 g, 5.65 mmol), and benzoyl peroxide (0.2 g, 0.56 mmol) is then added and the reaction mixture is heated for an additional 3 hours. After cooling to ambient temperature, the reaction mixture is filtered. The filtrate is concentrated to a brown oil which is triturated with hexane to remove residual succinimide, filtered, and concentrated. The resultant oil (4.5 g, >100%) is used directly in the next reaction without further purification. ¹H NMR (300 MHz, CDCl₃) δ 1.72 (s, 9H), 4.88 (s, 2H), 6.63 (s, 1H), 7.27 (dd, J = 9.0, 2.0 Hz, 1H), 7.46 (d, J = 2.0 Hz, 1H), 8.09 (d, J = 9.0 Hz, 1H) ppm; MS (EI): m/z 343 (M⁺).

10 EXAMPLE 22. 3-Bromomethyl-5-iodo-2-methoxy-pyridine

A. 5-Iodo-3-methyl-2-methoxy-pyridine.

To a solution containing 2-bromo-5-iodo-3-methyl-pyridine (4.80 g, 16.0 mmol) in DMSO (15 mL) is added methanolic NaOMe (3.33 M, 5.3 mL, 17.7 mmol) at 0 °C. The solution is allowed to warm to ambient temperature and then heated at 70°C for 1 hour. The reaction mixture is diluted with diethyl ether (300 mL) and water (200 mL) and the layers are separated. The organic phase is washed with brine, dried over anhydrous Na₂SO₄, filtered and concentrated. The crude product is purified by silica gel flash column chromatography (hexane/diethyl ether, 19:1) to provide 2.86 g (71%) of the title compound as a white solid. ¹H NMR (300 MHz, CDCl₃) δ 2.12 (s, 3H), 3.90 (s, 3H), 7.60 (d, J = 2.1 Hz, 1H), 8.14 (d, J = 2.1 Hz, 1H) ppm; MS (EI): m/z 249 (M⁺).

B. 3-Bromomethyl-5-iodo-2-methoxy-pyridine.

A solution containing 5-iodo-3-methyl-2-methoxy-pyridine (1.00 g, 4.00 mmol) and NBS (0.78 g, 4.40 mmol) in CCl₄ (20 mL) is warmed to reflux. AIBN is added in 5 mg portions (0.03 mmol) every hour. After 3 h, the reaction mixture is cooled and then concentrated in vacuo. The residue is dissolved in EtOAc (150 mL) and washed successively with aqueous Na₂S₂O₃ (100 mL), water (100 mL), brine then dried over anhydrous Na₂SO₄, filtered and concentrated. The crude product is purified by silica gel flash column chromatography (hexane/diethyl ether, 19:1) to provide 0.72 g (55%) of the title compound as a white solid. ¹H NMR (300 MHz, CDCl₃) δ 3.97 (s, 3H), 4.38 (s, 2H), 7.83 (d, J = 2.2 Hz, 1H), 8.27 (d, J = 2.2 Hz, 1H) ppm; MS (EI): m/z 327 (M⁺).

EXAMPLE 23. 5-Bromomethyl-6-methoxy -nicotinic acid methyl ester.

A. 6-Methoxy-5-methyl-nicotinic acid methyl ester.

A solution containing 5-iodo-3-methyl-2-methoxy-pyridine (10.0 g, 40.0 mmol), Et₃N (8.0 g, 80.0 mmol), and (Ph₃P)₄PdCl₂ (2.80 g, 4.00 mmol) in 1:1 DMF/MeOH (100 mL) is cooled to

0°C. Carbon monoxide is bubbled into the cooled solution for approx. 5 min at which time the reaction mixture is sealed under a balloon of CO. The reaction mixture is allowed to warm to ambient temperature and then stirred for 16 hours. The reaction mixture is concentrated in vacuo and the residue is partitioned between water (300 mL) and EtOAc (300 mL) and the layers are separated. The organic phase is washed with brine, dried over anhydrous Na₂SO₄, filtered and concentrated. The crude product is purified by silica gel flash column chromatography (hexane/diethyl ether, 19:1) to provide 4.10 g (57%) of the title compound as a white solid. ¹H NMR (300 MHz, CDCl₃) δ 2.20 (s, 3H), 3.88 (s, 3H), 4.00 (s, 2H), 7.96 (d, J = 2.2 Hz, 1H), 8.65 (d, J = 2.2 Hz, 1H) ppm; MS (ISP loop): m/z 182 (M+H).

10 B. 5-Bromomethyl-6-methoxy-nicotinic acid methyl ester.

A solution containing 6-methoxy-5-methyl-nicotinic acid methyl ester (4.00 g, 22.1 mmol), NBS (5.11 g, 28.7 mmol), and AIBN (0.90 g, 5.5 mmol) in CCl₄ (100 mL) is warmed to reflux. After 5 h, the reaction mixture is cooled and then concentrated in vacuo. The residue is dissolved in EtOAc (500 mL) and washed successively with aqueous Na₂S₂O₃ (300 mL), water (100 mL), brine then dried over anhydrous Na₂SO₄, filtered and concentrated. The crude product is purified by silica gel flash column chromatography (hexane/diethyl ether, 9:1) to provide 3.10 g (54%) of the title compound as a white solid. ¹H NMR (300 MHz, CDCl₃) δ 3.90 (s, 3H), 4.07 (s, 3H), 4.46 (s, 2H), 8.19 (d, J = 2.2 Hz, 1H), 8.79 (d, J = 2.2 Hz, 1H) ppm; MS (EI): m/z 259 (M+).

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EXAMPLE 24. 5-Chloro-2-thienyloxyacetic acid.

A. 2-Hydroxy-thiophene.

Thiophene (42g, 500mmol) is dissolved in ether (250mL). To the solution is added n-BuLi (200mL of a 2.5N solution in hexanes, 500mmol) at a rate which maintains a gentle reflux. After addition, the solution is stirred for 0.5 hour. The solution is then cooled to -78°C and triethyl borate (102 g, 700mL) is added dropwise. The solution is stirred for 3 hours. The cold bath is removed and 130mL of a 30% H₂O₂ is added dropwise with rapid stirring. After addition, the solution is allowed to reflux for an additional 20 minutes. The solution is then cooled to 0°C and acidified to pH=3 with 6N HCl. The resulting solution is extracted with ether. The organic solution is washed with 10% ferric ammonium sulfate, water and saturated NaCl. The solution is dried over MgSO₄, filtered and concentrated under vacuum. The title compound (32g, 320mmol) is obtained as an oil. ¹H NMR (CDCl₃, 300MHz) δ 7.60 (m, 1H), 6.35 (m, 1H), 4.12 (d, 2H).

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B. Ethyl 2-thienyloxyacetate.

To a solution of 2-hydroxy-thiophene (32g, 320 mmol) in CHCl_3 (500mL) is added ethyl bromoacetate (53.4 g, 320 mmol). To the resulting solution is added a solution containing n-Bu₄NHSO₄ (25g, 74mmol) and NaOH (15.8g, 394 mmol) in water (500mL). After addition, the solution is stirred vigorously using mechanical stirring. The reaction is stirred for 12 hours.

- 5 After this time, the layers are separated. The aqueous layer is extracted with CHCl_3 . The combined organic layers are washed with water and saturated NaCl. The organic layer is dried over MgSO_4 , filtered and concentrated under vacuum. The resulting crude product is purified by column chromatography eluting with a gradient of 30% CH_2Cl_2 :hexanes to 60% CH_2Cl_2 :hexanes. The title compound (11.5g, 62mmol) is obtained as an oil.
- 10 ¹H NMR (CDCl_3 , 300MHz) δ 6.68 (dd, 1H), 6.60 (d, 1H), 6.22 (d, 1H), 4.62 (s, 2H), 4.30 (q, 2H), 1.31 (t, 3H).

C. Ethyl 5-chloro-2-thienyloxyacetate.

- To a solution of ethyl 2-thienyloxyacetate (1.1g, 5.9mmol) in acetic acid (15mL) is added N-chlorosuccinimide (0.78g, 5.9mmol). The solution is stirred for 1.5 hour. After this time the solution is concentrated. The resulting oil is dissolved in ether and washed with 1N NaOH,
- 15 water and sat. NaCl. The organic layer is dried over MgSO_4 , filtered and concentrated under vacuum. The title compound (1.26g, 5.7mmol) is obtained as an oil. ¹H NMR (CDCl_3 , 300MHz) δ 6.52 (d, 1H), 6.06 (d, 1H), 4.60 (s, 2H), 4.24 (q, 2H), 1.31 (t, 3H).

D. 5-Chloro-2-thienyloxyacetic acid.

- To a solution of ethyl 5-chloro-2-thienyloxyacetate (0.39g, 1.77mmol) in 9mL of a 1:1:1 mixture of CH_3OH :THF:water is added LiOH (0.38g, 9.0 mmol). The solution is stirred for 16 hours. After this time, the solution is concentrated to 1/3 its volume. The resulting solution is acidified to pH=3 with 1N HCl. The aqueous solution is extracted with CH_2Cl_2 . The organic layer is dried over MgSO_4 , filtered and concentrated under vacuum. The title compound (0.32g,
- 20 1.66mmol) is obtained as a white solid. ¹H NMR (CDCl_3 , 300MHz) δ 6.50 (d, 1H), 6.07 (d, 1H), 4.66 (s, 2H).

EXAMPLE 25. 3-(5-Chloro-thiophen-2-yl)-(E)-acrylic acid.

- To a mixture of 3-(5-chloro-thiophen-2-yl)-(E)-acrylic acid methyl ester (0.60 g, 2.96 mmol) in 15 mL of 1:1:1 THF/MeOH/ H_2O at 0°C is added lithium hydroxide monohydrate (0.62 g, 14.7 mmol). The mixture is stirred at 0°C for 1 h, then at room temperature for 1 h and concentrated in vacuo. The residue is diluted with EtOAc and washed with 1N HCl. The aqueous layer is extracted with EtOAc and the combined organics are washed with water (2x), dried, filtered and concentrated to provide the title compound (0.54 g, 2.86 mmol) as a white
- 30

solid. The crude material can be used in the subsequent step without further purification. ¹H NMR (CDCl₃, 300MHz) δ 7.65 (d, 1H), 7.05 (d, 1H), 6.90 (d, 1H), 6.10 (d, 1H).

EXAMPLE 26. 3-(4-Chloro-thiophen-2-yl)-(E)-acrylic acid.

5 A. 4-Chloro-2-thiophene-carboxaldehyde.

To a solution of 2-thiophene-carboxaldehyde (6.33 g, 56.4 mmol) in 100 mL of CHCl₃ at 0°C is added aluminum trichloride (16.8 g, 126 mmol) portionwise over a few minutes. In a separate vessel, chlorine gas (4.00 g) is bubbled for about 2 min into 100 mL of CCl₄ at 0°C and then added to the former mixture slowly at 0°C. The resulting mixture is stirred at 0°C for 45
10 min, then allowed to warm to room temperature and stirred overnight. After 16 h, the reaction mixture is poured slowly into 6N HCl at 0°C, then stirred at room temperature for 2 hours. The layers are separated. The aqueous layer is extracted with CHCl₃. The combined organic layers are washed with H₂O and saturated NaCl solution, then dried over MgSO₄, filtered and concentrated. The crude product is purified by column chromatography eluting with 10%
15 EtOAc/hexanes to yield the title compound (6.70 g, 45.9 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 9.87 (s, 1H), 7.64 (s, 1H), 7.63 (s, 1H).

B. 3-(4-Chloro-thiophen-2-yl)-(E)-acrylic acid methyl ester.

The title compound is prepared as described in EXAMPLE 1, Part A from 4-chloro-2-thiophene-carboxaldehyde. ¹H NMR (CDCl₃, 300 MHz) δ 7.69 (d, 1H), 7.15 (s, 1H), 7.11 (s,
20 1H), 6.25 (d, 1H), 3.82 (s, 3H).

C. 3-(4-Chloro-thiophen-2-yl)-(E)-acrylic acid.

The title compound is prepared as described in EXAMPLE 1, Part B from 3-(4-chloro-thiophen-2-yl)-(E)-acrylic acid methyl ester. ¹H NMR (CDCl₃, 300 MHz) δ 7.77 (d, 1H), 7.19 (d,
25 2H), 6.25 (d, 1H).

EXAMPLE 27. (5-Chloro-thiophen-2-yl)-acetic acid.

A. [2-(5-Chloro-thiophen-2-yl)-1-dimethylaminovinyl]phosphonic acid diethyl ester.

To a suspension of sodium hydride (0.25 g, 6.25 mmol, 60% mineral oil dispersion) in
30 10 mL of THF is added slowly a solution of tetraethyl dimethylaminomethylenediphosphonate (2.03 g, 6.14 mmol, prepared according to the procedure described in Psaume, Montury, and Cosmetic Comm. 1982, 12, 415) in 10 mL of THF. After stirring 1 h, a solution of 5-chloro-2-thiophene carboxaldehyde (0.90 g, 6.14 mmol) in 10 mL of THF is added. The resulting mixture is heated at reflux for 1 h, then cooled to room temperature. The reaction mixture is partitioned
35 between Et₂O and water. The organic layer is washed sequentially with 1N HCl, water and

saturated NaCl, then dried over MgSO_4 , filtered and concentrated. The crude product is purified via flash column chromatography eluting with a gradient of 40% EtOAc/hexanes to 50% EtOAc/hexanes to afford the title compound (1.52 g, 4.69 mmol) as an oil. ^1H NMR (CDCl_3 , 300 MHz) δ 7.20 (d, 1H), 6.95 (d, 1H), 6.82 (d, 1H), 4.15 (m, 4H), 2.62 (s, 6H), 1.60 (t, 6H).

5 B. (5-Chloro-thiophen-2-yl)-acetic acid.

A mixture of [2-(5-chloro-thiophen-2-yl)-1-dimethylaminovinyl]phosphonic acid diethyl ester (1.52 g, 4.69 mmol) and 30 mL of 6N HCl is heated at reflux for 2 hours. After cooling to room temperature, ice water is added and the mixture is partitioned between Et_2O and water. The organic layer is washed with water (2x), dried over MgSO_4 , filtered and concentrated to
10 give the title compound (0.62 g, 3.51 mmol) as a brown solid. The crude material can be used in the subsequent step without further purification. ^1H NMR (CDCl_3 , 300 MHz) δ 8.30 (bs, 1H), 7.79 (d, 1H), 6.71 (d, 1H), 3.81 (s, 2H).

EXAMPLE 28. 3-(5-Chloro-thiophen-2-yl)-propionic acid.

15 A. 3-(5-Chloro-thiophen-2-yl)-propionaldehyde.

To a mixture of $\text{Pd}(\text{OAc})_2$ (0.12 g, 0.53 mmol), NaHCO_3 (0.52 g, 6.19 mmol) and NaI (0.28 g, 1.87 mmol) in 5 mL of HMPA is added 5-bromo-2-chloro-thiophene (1.00 g, 5.06 mmol) and allyl alcohol (1.03 mL, 15.2 mmol). The mixture is heated to 90°C and stirred for 16 hours. The reaction mixture is cooled to room temperature, diluted with Et_2O and washed with water.
20 The organic layer is dried over MgSO_4 , filtered and concentrated in vacuo. The crude residue is purified by flash column chromatography eluting with a gradient of 10% Et_2O /hexanes to 20% Et_2O /hexanes to provide the product (0.18 g, 1.03 mmol) as an oil. ^1H NMR (CDCl_3 , 300 MHz) δ 9.81 (s, 1H), 6.71 (d, 1H), 6.58 (d, 1H), 3.07 (t, 2H), 2.81 (t, 2H).

B. 3-(5-Chloro-thiophen-2-yl)-propionic acid.

25 Silver nitrate (117 mg, 0.69 mmol) in 1 mL of H_2O is added to 1.36 mL of 1N NaOH at 0°C and stirred for 5 minutes. To the brown suspension is added 3-(5-chloro-thiophen-2-yl)-propionaldehyde (60 mg, 0.34 mmol) and the resulting mixture is allowed to warm to room temperature over 2 hours. The precipitate is filtered and washed with hot water (2x). The combined aqueous layers are acidified with 6 N HCl and extracted with EtOAc (2x). The
30 combined organic layers are washed with water (2x), then dried over MgSO_4 , filtered and concentrated in vacuo to give the title compound (50 mg, 0.26 mmol) as a beige solid. The crude material can be used in the subsequent step without further purification. ^1H NMR (CDCl_3 , 300 MHz) δ 6.72 (d, 1H), 6.60 (d, 1H), 3.07 (t, 2H), 2.71 (t, 2H).

35 EXAMPLE 29. 3-Fluorophenoxy-acetic acid.

A. 3-Fluorophenoxy-acetic acid ethyl ester.

To a solution of 3-fluorophenol (1.2g, 11.8mmol) in 20mL of DMF at 0°C is added sodium hydride (0.47g, 10.7mmol). After stirring for 10 minutes Ethyl bromoacetate (1.2g, 10.7 mmol) is added dropwise. The reaction is allowed to warm to ambient temperatures and is stirred for 16 hours. To the reaction is added a saturated solution NH₄Cl (aq.). The resulting mixture is diluted with EtOAc and H₂O. The layers are separated. The organic layer is washed with H₂O and a saturated solution NaCl (aq.). The organic layer is dried over MgSO₄, filtered and concentrated to give the product (2g, 10mmol) as an oil. ¹H NMR (CDCl₃, 300MHz) δ 7.22 (m, 1H), 6.65 (m, 3H), 4.61 (s, 2H), 4.27 (q, 2H), 1.24 (t, 3H).

B. 3-Fluorophenoxy-acetic acid.

To a solution of ethyl 3-fluorophenoxy-acetate (2g, 10mmol) in 24mL of a 1:1:1 solution of MeOH:H₂O:THF is added lithium hydroxide monohydrate (2.25g, 54mmol). The solution is stirred for 16 hours. After this time, the solution is concentrated under reduced pressure to 1/3 of its volume. The remaining solution is acidified to pH=3 with 1N HCl (aq.). The aqueous solution is extracted with EtOAc. The organic layer is washed with a saturated solution NaCl (aq.). The organic layer is dried over MgSO₄, filtered and concentrated to give the product (1.65g, 9.7mmol) as a white solid. ¹H NMR (CDCl₃, 300MHz) δ 9.8 (bs, 1H), 7.28 (m, 1H), 6.69 (m, 3H), 4.70 (s, 2H).

EXAMPLE 30. 2-Chloropyridin-3-ylamino-acetic acid.

To a solution of 3-amino-2-chloropyridine (1.0g, 7.8mmol) in 20mL of MeOH is added glyoxylic acid (0.86mL of a 50% by weight solution in H₂O, 7.8mmol). After stirring for 10 minutes, NaCNBH₃ (1.54 g, 23mmol) is added. The reaction is stirred for 16 hours., then is concentrated under reduced pressure. The resulting residue is dissolved in H₂O. The solution is acidified to pH=3 with 1N HCl (aq.). The solution is extracted with EtOAc/CH₂Cl₂ (2:1). The organic layer is dried over MgSO₄, filtered and concentrated. The resulting product is obtained as a white solid (0.95g, 5.1mmol). ¹H NMR (d₆-DMSO, 300MHz) δ 12.7 (bs, 1H), 7.62 (m, 1H), 7.44 (m, 1H), 6.90 (m, 1H), 5.8 (bs, 1H), 3.95 (AB, 2H), 4.70 (s, 2H).

EXAMPLE 31. 5-Chlorothiophen-2-yl-sulfanyl acetic acid.

A. Thiophen-2-yl-sulfanyl acetic acid ethyl ester.

To a solution of thiophene-2-thiol (1.49g, 116mmol) in 40mL of CH₃CN is added ethyl bromoacetate (2.14g, 167mmol) followed by K₂CO₃ (3.54g, 138mmol). The solution is stirred for 16 hours. After this time, the solution is filtered. The solvent is evaporate to give the

product as an oil (2.4g, 118mmol). ^1H NMR (CDCl_3 , 300MHz) δ 7.37 (m, 1H), 7.21 (m, 1H), 6.94 (m, 1H), 4.15 (q, 2H), 3.48 (s, 2H), 1.20 (t, 3H). MS (EI): m/z 202 (M^+).

B. 5-Chlorothiophen-2-yl sulfanyl acetic acid.

To a solution of thiophen-2-yl-sulfanyl acetic acid ethy (0.52g, 2.6mmol) in 25 mL of CH_2Cl_2 is added N-chlorosuccinimide (0.35g, 2.6mmol). The solution is stirred for 10 minutes. After this time, 1 drop of TFA is added. The solution is stirred for 16 hours. The reaction mixture is then diluted with 25 mL of CH_2Cl_2 . The resulting solution is washed with 1N NaOH and a saturated NaCl solution. The organic layer is dried over MgSO_4 , filtered and concentrated. The resulting product is obtained as an oil which is determined to contain 45% of the desired product. The oil is then dissolved in 60 mL of 1:1:1 THF:MeOH:H₂O. To the solution is added lithium hydroxide monohydrate (1.26g, 30mmol). The solution is stirred for 16 hours. After this time, the solution is acidified to pH=3 with 1N HCl. The aqueous solution is washed with H₂O and saturated NaCl solution. The solution is extracted with EtOAc/ CH_2Cl_2 (2:1). The organic layer is dried over MgSO_4 , filtered and concentrated. The resulting crude product is purified by column chromatography eluting with 20% MeOH:Et₂O to give the product as a white solid (0.4g, 1.9mmol). MS (EI): m/z 208, 210 (M^+), Cl pattern.

EXAMPLE 32. 5'-Chloro-[2,2']bithiophenyl-5-carboxylic acid.

A. 5'-Chloro-[2,2']bithiophenyl-5-carbaldehyde.

To a solution of 5-chloro-[2,2']bithiophene (1.06 g, 5.28 mmol) in 12 mL of THF at -78°C is added n-BuLi (4.4 mL of a 1.6M solution in hexanes, 6.99 mmol). After 15 minutes, DMF (0.97 mL, 14 mmol) is added and the resulting solution is allowed to warm to 0°C . After 15 min, the solution diluted with EtOAc and quenched with saturated NaHCO_3 solution. The organic solution is washed with H₂O and saturated NaCl solution, then dried over MgSO_4 , filtered and concentrated. The crude product is purified by flash column chromatography eluting with a gradient of 10% Et₂O/hexanes to 20% Et₂O/hexanes to yield the title compound (0.89 g, 3.89 mmol) as a white solid. ^1H NMR (CDCl_3 , 300 MHz) δ 9.87 (s, 1H), 7.70 (d, 1H), 7.20 (d, 1H), 7.15 (d, 1H), 6.91 (d, 1H).

B. 5'-Chloro-[2,2']bithiophenyl-5-carboxylic acid.

The title compound is prepared as described in EXAMPLE 28, Part B using 5'-chloro-[2,2']bithiophenyl-5-carbaldehyde. ^1H NMR (CDCl_3 , 300 MHz) δ 7.69 (d, 1H), 7.09 (d, 1H), 7.06 (d, 1H), 6.89 (d, 1H). EI MS, $[\text{M}]^+=243,245$ (Cl pattern).

EXAMPLE 33. 7-Chloro-isoquinoline-3-carboxylic acid.

A. 7-Chloro-isoquinoline-3-carbaldehyde.

A 20mL of 80% H₂SO₄ is added 7-chloro-3,3-dibromomethyl isoquinoline (0.69g, 2.06mmol) is heated to 150°C for 16 hours. The solution is then cooled to ambient temperatures and diluted with 40 mL of H₂O. The resulting solution is basified to pH=11 with 1N NaOH. The aqueous solution is extracted with CH₂Cl₂. The organic solution is washed with H₂O and a saturated NaCl solution. The organic layer is dried over MgSO₄, filtered and concentrated to give the product as an oil (0.25g, 1.3 mmol). ¹H NMR (CDCl₃, 300MHz) δ 10.0 (s, 1H), 9.30 (s, 1H), 8.36 (s, 1H), 8.07 (s, 1H), 7.95 (d, 1H), 7.78 (d, 1H). MS (EI): m/z 191, 193 (M⁺), Cl pattern.

B. 7-Chloro-isoquinoline-3-carboxylic acid.

To 4.5 mL of a 1N NaOH solution at 0°C is added a solution of AgNO₃ (0.31g, 1.8mmol) in 3 mL of H₂O, followed by a solution of 7-chloro-isoquinoline-3-carbaldehyde (0.25g, 1.3mmol) in 3 mL of EtOH. The solution is stirred at 0°C for 10 minutes, then at room temp. For 3 hours. The solution is acidified to pH=3 with 1N HCl. The resulting solution is extracted with CHCl₃. The organic layer is dried over MgSO₄, filtered and concentrated to give the product as a white solid (0.2g, 0.96mmol). ¹H NMR (CD₃OD, 300MHz) δ 9.18 (s, 1H), 8.63 (s, 1H), 8.18 (m, 1H), 7.80 (m, 2H), 6.94 (m, 1H), 4.15 (q, 2H), 3.48 (s, 2H), 1.20 (t, 3H). MS (EI): m/z 208, 210 (M⁺), Cl pattern.

EXAMPLE 34. 2-Acetylamino-3-(5-chloro-thiophen-2-yl)-acrylic acid.

A. 4-(5-Chloro-thiophen-2-ylmethylene)-2-methyl-4H-oxazol-5-one.

A mixture consisting of 5-chlorothiophene-2-carboxaldehyde (1.00 g, 6.82 mmol), N-acetylglycine (0.96 g, 8.18 mmol), NaOAc (0.67 g, 8.18 mmol) in Ac₂O (5 mL) is warmed at reflux for 16 hours. The reaction mixture is cooled to ambient temperature and diluted with dilute aqueous NaOH (0.5 M, 100 mL) and CH₂Cl₂ (100 mL). The layers are separated and the organic phase is washed with aqueous NaHCO₃, brine, dried over anhydrous Na₂SO₄, filtered and concentrated to provide 1.5 g (100%) of the title compound as a colorless oil which is used without further purification in the next reaction. ¹H NMR (300 MHz, CDCl₃) δ 2.39 (s, 3H), 6.94 (d, J = 4.0 Hz, 1H), 7.21 (s, 1H), 7.26 (d, J = 4.0 Hz, 1H) ppm.

B. 2-Acetylamino-3-(5-chloro-thiophen-2-yl)-acrylic acid.

To a solution containing 4-(5-chloro-thiophen-2-ylmethylene)-2-methyl-4H-oxazol-5-one (1.5 g, 6.82 mmol) in MeOH (18 mL) is added 1.0 M NaOH (12.0 mL, 12 mmol) at ambient temperature. After 3 h, the reaction mixture is diluted with water (100 mL) and CH₂Cl₂ (100 mL) and the layers are separated. The basic, aqueous layer is washed with CH₂Cl₂ and then acidified using 1.0 M HCl (20 mL) to provide a crude solid which is collected on a Buchner

funnel. Drying in vacuo provided 1.2 g (75%) of the title compound as a pale brown solid which is used without further purification. ¹H NMR (300 MHz, DMSO-d₆) δ 2.00 (s, 3H), 7.14 (d, J = 4.01 Hz, 1H), 7.38 (d, J = 4.01 Hz, 1H), 7.63 (s, 1H), 9.28 (s, 1H), 12.73 (br s, 1H) ppm; MS (EI): m/z 245 (M⁺).

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EXAMPLE 35. 2-Acetylamino-3-(5-chloro-thiophen-2-yl)-propionic acid.

To a solution containing 2-acetylamino-3-(5-chloro-thiophen-2-yl)-acrylic acid (1.00 g, 4.08 mmol) and K₂CO₃ (1.70 g, 12.1 mmol) in DMF (20 mL) is added MeI (0.87 g, 6.12 mmol) at ambient temperature. After 2 h, the reaction mixture is diluted with water (100 mL) and EtOAc (100 mL) and the layers are separated. The aqueous layer is extracted with EtOAc (50 mL) and the combined organic phase is washed with brine, dried over anhydrous Na₂SO₄, filtered and concentrated to provide 0.92 g (83%) of the methyl ester which is used without further purification. ¹H NMR (300 MHz, CDCl₃) δ 2.19 (s, 3H), 3.77 (s, 3H), 6.86 (d, J = 4.02 Hz, 1H), 6.99 (m, 1H), 7.05 (d, J = 4.02 Hz, 1H), 7.64 (s, 1H) ppm.

15 A small Parro vessel is charged with the crude ester (0.85 g, 3.13 mmol) and

(Ph₃P)₃RhCl (0.10 g, 0.10 mmol) in MeOH (50 mL). The vessel is pressurized to 50 PSI H₂ pressure and agitated for 7 h at ambient temperature. The reaction mixture is then filtered and concentrated to provide the desired compound, which is used without further purification. MS (EI): m/z 261 (M⁺).

20 The above-prepared saturated ester is dissolved in a 1:1:1 solution of water/THF/MeOH (15 mL). LiOH monohydrate (0.14 g, 3.23 mmol) is added and the heterogeneous mixture is stirred for 16 hours. The reaction mixture is diluted with water (100 mL) and EtOAc (100 mL) and the layers are separated. The aqueous layer is extracted with EtOAc (50 mL) and the combined organic phase is washed with brine, dried over anhydrous Na₂SO₄, filtered and concentrated to provide 0.62 g (81%) of the title compound as a colorless oil. ¹H NMR (300 MHz, CDCl₃) δ 2.02 (s, 3H), 3.30 (m, 2H), 4.81 (m, 1H), 6.45 (br d, J = 6.45 Hz, 1H), 6.58 (d, J = 3.68 Hz, 1H), 6.71 (d, J = 3.68 Hz, 1H), 9.79 (br s, 1H) ppm; MS (EI): m/z 247 (M⁺).

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EXAMPLE 36. 3-(6-Amino-pyridin-3-yl)-acrylic acid.

30 A. N-(5-Bromo-pyridin-2-yl)-acetamide.

Triethylamine (17.7 mL, 75 mmol) is added to a mixture of 2-amino-5-bromopyridine (5.0 g, 29 mmol) and acetic acid (7.1 mL, 75 mmol). The solution is heated to reflux for 48 hours. After this time, the solution is concentrated. The residue is dissolved in water and the pH is adjusted to 10 with 1N NaOH. The solids are collected by filtration. The crude product is

recrystallized from boiling water to give the title compound (2.6 g 12.0 mmol) as a white solid.

^1H NMR (300 MHz, CDCl_3) δ 10.62 (1H, bs), 8.42 (s, 1H), 8.01 (m, 2H), 2.05 (s, 3H).

B. 3-(6-Acetylamino-pyridin-3-yl)-acrylic acid

To a mixture of N-(5-bromo-pyridin-2-yl)-acetamide (1.26 g, 5.86 mmol) and tri-n-butylamine in xylenes (10 mL) is added $\text{Pd}(\text{OAc})_2$ (1.4 mg, 0.006 mmol) and triphenyl phosphine (15.4 mg, 0.06 mmol). Acrylic acid (0.48 mL, 7.03 mmol) is then added dropwise over 5 minutes. The mixture is heated to reflux for 5 hours. The solution is cooled to ambient temperatures. The mixture is diluted with water and the pH is adjusted to 4 with 1N HCl. The solution is extracted with $\text{EtOAc}/\text{CH}_2\text{Cl}_2$ (2:1). The resulting suspension is filtered to give the title compound (0.80 g, 3.88 mmol) as a white solid. MS (ion spray) 207, (M+H).

C. 3-(6-Amino-pyridin-3-yl)-acrylic acid

To 3-(6-acetylamino-pyridin-3-yl)-acrylic acid (0.80 g, 3.88 mmol) in ethanol (10 mL) is added 1N NaOH (20 mL). The solution is heated to reflux. After 16 h, the solution is concentrated to 1/3 its volume. The aqueous solution is diluted with water and acidified to pH=2 with 6N HCl. The solution is concentrated to dryness. The residue is dissolved in methanol. The solution is filtered. The organic solution is concentrated. The crude product is purified by RP-HPLC eluting with a gradient of 5% $\text{CH}_3\text{CN}/\text{H}_2\text{O}$ (0.1% TFA) to 30% $\text{CH}_3\text{CN}/\text{H}_2\text{O}$ (0.1% TFA) to give the product as a white solid (0.54 g, 1.93 mmol). ^1H NMR (300 MHz, CD_3OD) δ 8.34 (d, 1H), 8.07 (s, 1H), 7.54 (d, 2H), 7.06 (d, 1H), 6.47 (d, 1H). MS (ion spray) 165, (M+H).

EXAMPLE 37. 4-Chloro-benzyl isocyanate.

To a solution of triphosgene (0.54 g, 1.85 mmol) in 10 mL of dry CH_2Cl_2 at 0°C is added 4-chloro-benzylamine (0.61 mL, 5.00 mmol) dropwise as a white precipitate forms. Et_3N (1.39 mL, 10.0 mmol) in 5 mL of CH_2Cl_2 is added immediately and the resulting mixture is stirred at 0°C for 5 min, then at room temperature for 3 hours. The mixture is concentrated in vacuo and triturated with EtOAc. The white precipitate (triethylamine hydrochloride) is filtered off and the filtrate is concentrated. The title compound (6.20 g, 30.6 mmol) is isolated as a crude yellow residue and used in the subsequent step without further purification. ^1H NMR (CDCl_3 , 300 MHz) δ 7.35 (d, 2H), 7.25 (d, 2H), 4.50 (s, 2H).

EXAMPLE 38. 5-Chloro-thiophene-2-carbonyl azide.

To a solution of 5-chloro-2-thiophene-carboxylic acid (5.00 g, 30.7 mmol) in 130 mL of acetone is added Et_3N (4.29 mL, 30.7 mmol). The mixture is cooled to 0°C and ethyl chloroformate (3.23 mL, 33.8 mmol) is added. The mixture is stirred at 0°C for 1h and sodium

azide (3.40 g, 52.3 mmol) is added. The mixture is stirred at 0°C for 2 h, then poured into 300 mL of ice water and the aqueous layer is extracted with CH₂Cl₂ (2x). The combined organics are washed with water (2x) and brine, then dried, filtered and concentrated. The crude residue is purified via flash column chromatography eluting with 10% EtOAc/hexanes to provide the title compound (3.00 g, 16.0 mmol) as a white solid. ¹H NMR (CDCl₃, 300 MHz) δ 7.67 (d, 1H), 6.99 (d, 1H).

EXAMPLE 39. 4-Nitro-2,3,5,6-tetrachloropyridine.

Pentachloropyridine (80 g, 320 mmol) is treated with benzyl amine (104 mL, 96 mmol), dissolved in dioxane (1 L) and refluxed for 16 hours. The reaction mixture is cooled to ambient temperature and the precipitated white solid is removed by filtration. The filtrate is concentrated to a brown residue and triturated with 4 % ethyl acetate in hexane (3 X 250 mL) to give 4-benzylamino-2,3,5,6-tetrachloropyridine as an off-white solid (40 g, 124 mmol). This material is dissolved in chloroform (400 mL), cooled in an ice bath and treated with trifluoroacetic acid (500 mL) and 30% hydrogen peroxide (100 mL). The reaction mixture is warmed to room temperature overnight and treated with additional trifluoroacetic acid (500 mL) and 30% hydrogen peroxide (100 mL). After stirring 24 hours the reaction is treated with water (1L). The lower organic layer is separated and the aqueous layer is extracted with chloroform. The combined organic layers are concentrated to a solid residue and redissolved in ethyl acetate/hexane (30 mL). The suspended orange solid is removed and the filtrate is loaded on a silica flash column. The column is eluted with hexane and the title compound is collected as a white solid (15.6 g, 60 mmol). EI MS m/z 260, 262, 264 [M⁺].

EXAMPLE 40. 4-(tert-Butyloxycarbonyl)-piperazin-2-one

4-(Benzyloxycarbonyl)-piperazin-2-one (2.2 g, 9.4 mmol) and Boc anhydride (2.5 g, 11.3 mmol) are dissolved in methanol (100 mL), treated with 5% Pd /C and shaken 16 h under hydrogen gas (30 PSI). The reaction vessel contents are filtered through Celite and the filtrate is concentrated to yield 4-(tert-Butyloxycarbonyl)-2-oxopiperazine (1.9 g, 9.4 mmol) which is used without further purification. EI MS m/z 200, M⁺; ¹H NMR (CDCl₃, 300 MHz) δ 6.17 (br, 1H), 4.20 (s, 2H), 3.55 (t, 2H), 3.38 (m, 2H), 1.48 (s, 9H).

EXAMPLE 41. 2-Methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

A. N-Cbz-O-methylserine-aminoacetaldehyde dimethyl acetal.

To a solution of N-Cbz-O-methylserine (10.8g, 41.8mmol) in 500mL of CH₂Cl₂ is added Et₃N (12.7 g, 125mmol). The solution is cooled to 0°C and TBTU (13.5g, 42mmol) and

aminoacetaldehyde dimethyl acetal (4.83g, 46mmol) are added. The solution is stirred for 16 hours. The solution is diluted with 500mL of ether. The resulting solution is washed with water, 1N KHSO₄, and sat. NaCl. The title compound (13.7g, 41.8mmol) is obtained as a white foam.

¹H NMR (CDCl₃, 300MHz) δ 7.40 (m, 5H), 6.55 (bs, 1H), 5.66 (bs, 1H), 5.32 (m, 1H), 5.13 (s, 2H), 4.32 (m, 2H), 3.79 (dd, 1H), 3.44 (m, 2H), 3.40 (m, 9H).

B. N-Cbz-2-Oxo-3-(S)-methoxymethyl-(4,5-dihydro)piperazine.

To a solution of N-Cbz-O-methylserine-aminoacetaldehyde dimethyl acetal (13.7g, 41.8mmol) in 300mL of toluene is added TsOH.H₂O (0.80g, 4.2mmol). The solution is heated to 60°C. After 5h, the solution is diluted with ether. The resulting organic solution is washed with water, sat. NaHCO₃, and sat. NaCl. The organic layer is dried over MgSO₄, filtered and concentrated under vacuum. The resulting crude product is purified by column chromatography eluting with a gradient of 10%EtOAc:CH₂Cl₂ to 20%EtOAc:CH₂Cl₂. The title compound (10.7g, 38mmol) is obtained as a white solid. ¹H NMR (CDCl₃, 300MHz) δ 7.36 (m, 5H), 6.45 and 6.30 (d, 1H rotational isomers), 5.61 and 5.50 (d, 1H rotational isomers), 5.20 (s, 2H), 4.92 and 4.83 (bs, 1H rotational isomers), 3.63 (m, 3H), 3.32 and 3.20 (s, 1H rotational isomers).

C. 2-Methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

To a solution of N-Cbz-2-oxo-3-(S)-methoxymethyl-(4,5-dihydro)piperidine (10.7g, 38mmol) in 50mL of methanol is added Pt/C (1gm, 10% by weight). The atmosphere above the reaction is replaced by hydrogen. After 24h, the solution is filtered and the filtrate is washed with methanol. The collected organic solutions are concentrated under vacuum. The resulting crude product is purified by column chromatography eluting with a gradient of 2%MeOH/CH₂Cl₂ to 5%MeOH/CH₂Cl₂. The title compound (6.0g, 22mmol) is obtained as a white solid. ¹H NMR (CDCl₃, 300MHz) δ 7.35 (m, 5H), 6.42 (bs, 1H), 5.20 (AB, 2H), 4.58 (m, 1H), 4.18 (m, 1H), 3.95 (m, 1H), 3.50 (m, 4H), 3.27 (s, 3H).

EXAMPLE 42. 2-Butyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting Cbz-norleucine for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300mHz) δ 7.32 (m, 5H), 5.13 (AB, 2H), 4.60 (m, 1H), 4.13 (m, 1H), 3.38 (m, 2H), 3.23 (m, 2H), 1.90 (m, 1H), 1.66 (m, 1H), 1.29 (m, 4H), 0.89 (m, 3H). MS (ion spray) m/z 291, (M+H).

EXAMPLE 43. 2-Ethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting Cbz-2-amino-butric acid for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300mHz) δ 7.37 (m, 5H), 6.55 (bs, 1H), 5.10 (AB,

2H), 4.57 (m, 1H), 4.24 (m, 1H), 3.42 (m, 1H), 3.26 (m, 2H), 2.20 (m, 1H), 1.81 (m, 1H), 0.96 (m, 3H).

EXAMPLE 44. 2-Propyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting Cbz-norvaline for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300MHz) δ 7.32 (m, 5H), 7.00 (bs, 1H), 5.12 (AB, 2H), 4.58 (m, 1H), 4.21 (m, 1H), 3.40 (m, 1H), 3.19 (m, 2H), 1.88 (m, 1H), 1.73 (m, 1H), 1.37 (m, 2H), 0.91 (m, 3H). MS (ion spray) m/z 277, (M+H).

EXAMPLE 45. 2-Ethoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting Cbz-O-ethyl-serine for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300MHz) δ 7.32 (m, 5H), 6.96 (bs, 1H), 5.17 (AB, 2H), 4.58 (m, 1H), 4.18 (m, 1H), 4.03 (m, 1H), 3.66 (m, 2H), 3.44 (m, 3H), 3.27 (s, 1H), 1.06 (m, 3H). MS (ion spray) m/z 293, (M+H).

EXAMPLE 46. 2-Methyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting Cbz-alanine for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300MHz) δ 7.34 (m, 5H), 7.02 (bs, 1H), 5.17 (AB, 2H), 4.65 (m, 1H), 4.17 (m, 1H), 3.42 (m, 1H), 3.23 (m, 2H), 1.41 (d, 3H). MS (EI) m/z 248, (M+).

EXAMPLE 47. 2-Benzyl-3-oxo-piperazine-1-carboxylic acid benzyl ester

The title compound is prepared as in EXAMPLE 41, substituting Cbz-phenylalanine for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300MHz) δ 7.22 (m, 10H), 7.00 (bs, 1H), 5.10 (AB, 2H), 4.10 (m, 1H), 3.27 (m, 2H), 3.10 (m, 2H), 2.55 (m, 2H). MS (EI) m/z 324, (M+).

EXAMPLE 48. 2-(1-Methoxyethyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting Cbz-O-methyl-threonine for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300MHz) δ 7.52 (bs, 1H), 7.22 (m, 5H), 5.12 (AB, 2H), 4.33 (m, 1H), 4.05 (m, 2H), 3.60 (m, 1H), 3.14 (s, 3H), 3.10 (m, 1H), 2.82 (m, 1H), 1.10 (d, 3H). MS (ion spray) m/z 293, (M+H).

EXAMPLE 49. 2,2-Dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting Cbz-2-amino-isobutyric acid for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300MHz) δ 7.36 (m, 5H), 6.52 (bs, 1H), 5.12 (s, 2H), 3.72 (m, 2H), 3.33 (m, 2H), 1.68 (s, 3H), 1.64 (s, 3H). MS (EI) m/z 262, (M+).

EXAMPLE 50. 2-Isopropyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting Cbz-valine for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300MHz) δ 7.36 (m, 5H), 5.88 (bs, 1H), 5.10 (s, 2H), 4.35 (m, 1H), 3.44 (m, 1H), 3.27 (m, 2H), 2.31 (m, 1H), 1.00 (d, 3H), 0.94 (d, 2H).

EXAMPLE 51. 2-Isobutyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting Cbz-leucine for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300MHz) δ 7.35 (m, 5H), 6.50 (m, 1H), 5.15 (s, 2H), 4.18 (m, 1H), 3.42 (m, 2H), 3.21 (m, 2H), 1.50 (m, 3H), 0.90 (m, 6H).

EXAMPLE 52. 2-(2-Methoxyethyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting Cbz-O-methyl-homoserine for Cbz-O-methyl-serine. ¹H NMR (CDCl₃, 300MHz) δ 7.32 (m, 5H), 6.85 (bs, 1H), 5.14 (s, 2H), 4.75 (m, 2H), 4.20 (m, 2H), 3.42 (m, 1H), 3.21 (m, 3H), 2.12 (m, 4H).

EXAMPLE 53. 2-Methoxymethyl-5-methyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as in EXAMPLE 41, substituting 2-amino-propionaldehyde dimethyl acetal for aminoacetaldehyde dimethyl acetal. ¹H NMR (CDCl₃, 300MHz) δ 7.42 (m, 5H), 6.96 (bs, 1H), 5.12 (AB, 2H), 4.52 (m, 1H), 4.21 (m, 1H), 3.92 (m, 1H), 3.58 (m, 2H), 3.22 (s, 3H), 3.10 (m, 1H), 0.95 (m, 3H).

EXAMPLE 54. 3-(R)-(tert-Butyl-dimethyl-silanyloxymethyl)-5-oxo-piperazine-1-carboxylic acid benzyl ester.

A. 2-tert-Butoxycarbonylamino-3-(tert-butyl-dimethyl-silanyloxy)-propionic acid.

tert-Butyldimethylchlorosilane (32.3 g, 0.214 mol) in THF (50 mL) is added dropwise via cannula to a solution of BOC serine (20.0g, 0.098 mol) and imidazole (15.3 g, 0.224 mol) in THF (360 mL) at RT. The resulting slurry is stirred for 2.5 h then the solvent is removed in vacuo. The crude product is dissolved in MeOH (180 mL) and 5N NaOH (58 mL) is slowly added at RT. The mixture is stirred for 3 h then diluted with water (180 mL) after which time the aqueous layer is washed with ether (180 mLx2). The aqueous layer is acidified to pH 4-5 with 2N HCl and extracted with diethyl ether. The organic layer is washed with saturated NaHCO₃ and brine then dried over MgSO₄, filtered and concentrated to dryness. The crude product (12.67g, 0.040 mol) is used in the subsequent step without further purification. ¹H NMR (CDCl₃, 300 MHz) δ 5.35 (bs, 1H), 4.30 (bs, 1H), 4.13 (dd, 1H), 3.80 (dd, 1H), 1.45 (s, 9H), 0.98 (s, 9H), 0.10 (s, 6H). EI MS, [M+H]⁺=320.

B. [2-(tert-Butyl-dimethyl-silanyloxy)-1-(methoxy-methyl-carbamoyl)-ethyl]-carbamic acid tert-butyl ester.

N,N-Dimethylaminopyridine (2.60 g, 21.3 mmol) and BOP reagent (18.15 g, 41.0 mmol) are added to a solution of 2-tert-butoxycarbonylamino-3-(tert-butyl-dimethyl-silanyloxy)-propionic acid (12.37 g, 38.7 mmol), diisopropylethylamine (8.1 mL, 46.4 mmol) and N,O-dimethylhydroxylamine hydrochloride (4.53 g, 46.4 mmol) in THF (260 mL) at RT. The resulting suspension is stirred at RT overnight then concentrated to dryness. The residue is diluted with EtOAc and washed with saturated NH_4Cl , saturated NaHCO_3 and brine. The organic layer is dried over MgSO_4 , filtered and concentrated in vacuo to give the crude product which is purified by flash chromatography eluting with 10-30% EtOAc/Hexanes to yield the title compound (11.86 g, 30.37 mmol) as an oil. ^1H NMR (CDCl_3 , 300 MHz) δ 5.35 (bd, 1H), 4.71 (bs, 1H), 3.78-3.85 (m, 2H), 3.72 (s, 3H), 3.20 (s, 3H), 1.42 (s, 9H), 0.90 (s, 9H), 0.05 (s, 6H).

C. [1-(tert-Butyl-dimethyl-silanyloxymethyl)-2-oxo-ethyl]-carbamic acid tert-butyl ester.

A solution of [2-(tert-butyl-dimethyl-silanyloxy)-1-(methoxy-methyl-carbamoyl)-ethyl]-carbamic acid tert-butyl ester (11.86, 30.37 mmol) in Et_2O (100 mL) is added dropwise to a 1.0M solution of LAH in ether (35.5 mL) at -5°C - 0°C . The resulting mixture is stirred for 2.5 h then an aqueous solution of KHSO_4 is slowly added. The reaction mixture is stirred for 30 minutes and then washed with saturated NH_4Cl , saturated NaHCO_3 and brine. The organic layer is dried over MgSO_4 , filtered and concentrated in vacuo to give the crude product which is purified by flash chromatography eluting with 30% EtOAc/Hexanes to yield the title compound (6.04 g, 19.9 mmol) as an oil. ^1H NMR (CDCl_3 , 300 MHz) δ 9.65 (s, 1H), 5.30 (bs, 1H), 4.20 (m, 1H), 3.65 (4.90 (m, 2H), 1.48 (s, 9H), 0.90 (s, 9H), 0.05 (s, 6H). Ion spray MS, $[\text{M}+\text{H}]^+=304$.

D. [2-tert-Butoxycarbonylamino-3-(tert-butyl-dimethyl-silanyloxy)-propylamino]-acetic acid methyl ester.

Sodium cyanoborohydride (2.63 g, 41.9 mmol) is added to a solution of [1-(tert-butyl-dimethyl-silanyloxymethyl)-2-oxo-ethyl]-carbamic acid tert-butyl ester (6.04 g, 19.9 mmol) and glycine methyl ester hydrochloride (2.75 g, 32.9 mmol) in MeOH (500 mL). The mixture is stirred for 2 days at RT then concentrated to dryness. The crude product is purified by flash chromatography eluting with 1-5% MeOH/ CH_2Cl_2 to yield the title compound (3.06, 8.12 mmol) as a colorless oil. ^1H NMR (CDCl_3 , 300 MHz) δ 5.00 (bs, 1H), 3.75 (s, 3H), 3.60-3.70 (m, 4H), 3.40 (d, 1H), 2.80 (dd, 1H), 2.68 (dd, 1H), 1.40 (s, 9H), 0.90 (s, 9H), 0.05 (s, 6H). Ion spray MS, $[\text{M}+\text{H}]^+=377$.

E. (Benzyloxycarbonyl-[2-tert-butoxycarbonylamino-3-(tert-butyl-dimethyl-silanyloxy)-propyl]-amino)-acetic acid methyl ester.

Benzylchloroformate (1.4 mL, 9.81 mmol) is added dropwise to a solution of N,N-dimethylaminopyridine (1.09 g, 8.93 mmol) and [2-tert-butoxycarbonylamino-3-(tert-butyl-dimethyl-silyloxy)-propylamino]-acetic acid methyl ester (3.06 g, 8.12 mmol) in CH_2Cl_2 at RT. The resulting mixture is stirred overnight then concentrated to dryness. The crude product is
5 purified by flash chromatography eluting with 1% MeOH/ CH_2Cl_2 to yield the title compound (3.52 g, 6.89 mmol) as a colorless oil. Ion spray MS, $[\text{M}+\text{H}]^+=511$.

F. 3-(tert-Butyl-dimethyl-silyloxymethyl)-5-oxo-piperazine-1-carboxylic acid benzyl ester

(Benzyloxycarbonyl-[2-tert-butoxycarbonylamino-3-(tert-butyl-dimethyl-silyloxy)-propyl]-amino)-acetic acid methyl ester (3.52 g, 6.89 mmol) is stirred in 50% TFA/ CH_2Cl_2 (40
10 mL) at RT for 40 minutes. The reaction mixture is concentrated in vacuo and the crude product is purified by flash chromatography eluting with 1% MeOH/ CH_2Cl_2 to yield the title compound (1.1 g, 2.9 mmol) as a colorless oil. Ion spray MS, $[\text{M}+\text{H}]^+=379$.

EXAMPLE 55. 5-Oxo-piperazine-1,3(R or S)-dicarboxylic acid 1-benzyl ester 3-methyl ester.

15 N,N-Dimethylaminopyridine (0.43 g, 3.5 mmol) and benzylchloroformate (0.55 g, 3.8 mmol) are added to a solution of methyl 6-oxopiperazine-2-carboxylate (0.50 g, 3.2 mmol) (Aebischer, B., Helv. Chim. Acta 1989, 72, 1043-1051) in CH_2Cl_2 at RT. After 1 h, the reaction mixture is poured into EtOAc and washed with saturated NaHCO_3 and brine then dried over MgSO_4 , filtered and concentrated to dryness to give a solid (0.90 g, 3.1 mmol) which is used in
20 subsequent reactions without further purification. ^1H NMR (CDCl_3 , 300 MHz) δ 7.40 (bs, 5 H), 6.32 (bs, 1H), 5.15 (s, 2H), 4.00-4.30 (m, 3H), 4.23 (s, 3H), 3.70-3.80 (m, 2H). MS (EI) m/z 292 (M^+).

EXAMPLE 56. (S)-5-Oxo-piperazine-1,3-dicarboxylic acid 1-allyl ester 3-methyl ester.

25 To a solution containing methyl (S)-6-oxopiperazine-2-carboxylate (1.32 g, 8.35 mmol), prepared by the method of Aebischer, in anhydrous dichloromethane (30 mL) at 0 °C is added triethylamine (1.26 g, 12.5 mmol) followed by allylchloroformate (1.20 g, 10.0 mmol). After 1 h, the reaction mixture is poured onto a 1:1 mixture of CH_2Cl_2 /water (200 mL), acidified using 1 N HCl and the layers are separated. The organic phase is washed with brine, dried over
30 anhydrous Na_2SO_4 , filtered and concentrated. The crude residue is chromatographed on silica gel (CH_2Cl_2 to 1% MeOH/ CH_2Cl_2) to provide 1.22 g (60%) of EXAMPLE 35 as a viscous oil. ^1H NMR (300 MHz, CDCl_3) δ 6.43 (bs, 1H), 5.90 (m, 1H), 5.26 (m, 2H), 4.61 (m, 2H), 4.05-4.26 (m, 3H), 3.80 (s, 3H), 3.72 (m, 2H); MS (ISP loop): m/z 243 ($\text{M}+\text{H}$).

EXAMPLE 57. (2S, 6R)-4-(2,6-dimethyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester and

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EXAMPLE 58. (2S, 6S)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

A. (2RS, 1S)-[1-(2-hydroxy-propylcarbamyl)-ethyl]-carbamic acid tert-butyl ester

N-(tert-Butoxycarbonyl)-L-alanine (10.0 g, 52.8 mmol) is dissolved in 150 mL of THF. Once the triethylamine (11.0 ml, 79.2 mmol) is added, the solution is cooled to 0°C. Isopropyl chloroformate in toluene (1M) (52.8 ml, 52.8 mmol) is added slowly followed by the addition of (2RS) 1-amino-2-propanol (6.1 ml, 79.2 mmol). After stirring overnight, the mixture is washed with 1N sodium hydroxide and 1N hydrochloric acid. Concentration of the organic solvent afforded (2RS, 1S)-[1-(2-hydroxy-propylcarbamyl)-ethyl]-carbamic acid tert-butyl ester (9.92 g, 76% yield) as a clear oil.

B. (1S)-[1-(2-oxo-propylcarbamoyl)-ethyl]-carbamic acid tertbutyl ester

Dimethylsulfoxide (7.16 ml, 100.8 mmol) is added to a solution of oxalyl chloride (4.41 ml, 50.4 mmol) in 126 mL of methylene chloride at -78 °C. The mixture is left to stir for fifteen minutes, and a solution of (2RS, 1S)-[1-(2-hydroxy-propylcarbamyl)-ethyl]-carbamic acid tert-butyl ester (9.92 g, 40.32 mmol) in 100 mL of CH₂Cl₂ is added dropwise. After stirring for 15 minutes at -78 °C, the reaction is quenched with triethylamine (28 mL, 381 mmol), and the temperature is allowed to rise to room temperature. The volatile solvents are removed, and the residue is purified by flash column (SiO₂, 60% EtOAc/Hexane). The product (1S)-[1-(2-oxo-propylcarbamoyl)-ethyl]-carbamic acid tertbutyl ester (5.93 g, 60 %) is isolated as a white solid. MS C₁₁H₂₀N₂O₄ MS m/z: 245.

C: (3S, 5RS)-3,5-dimethyl-piperazin-2-one.

(1S)-[1-(2-oxo-propylcarbamoyl)-ethyl]-carbamic acid tertbutyl ester (5.93 g, 24.3 mmol) is stirred in a solution of 30 % trifluoroacetic acid in methylene chloride (100 mL) for three hours. The solvents are removed in vacuo. The residue is dissolved in 50 mL of MeOH and transferred to a par bottle. Palladium on carbon (10 %, 1.0 g) is added, and the mixture is hydrogenated under pressure for 24 hours. The catalyst is filtered off; the MeOH is removed in vacuo to afford (3S, 5RS)-3,5-dimethyl-piperazin-2-one which is directly protected with a benzyl carbamate without further purification.

D: (2S, 6RS)-2,6-Dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

To a solution of (3S, 5RS)-3,5-dimethyl-piperazin-2-one (24.3 mmol) in 100 mL of methylenechloride is added triethylamine (8.45 mL, 60.75 mmol) and N-(benzyloxycarbonyloxy)succinimide (12.1 g, 48.6 mmol). After stirring overnight, the CH₂Cl₂ is removed, and the crude mixture is chromatographed (50 % EtOAc/Hexane). (2S, 6RS)-2,6-Dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (3.3 g, 52 % yield over three steps) is isolated as a white powder. MS C₁₄H₁₈N₂O₃ MS m/z: 263.

E. (2S, 6R)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester and (2S, 6S)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester

The two single enantiomers [(2S, 6R)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester and (2S, 6S)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester] can be separated by column chromatography from (2S, 6RS)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, which can also be used directly in combination or separation of its derivatives as shown below.

EXAMPLE 59. (2S, 6R)-4-(2,4-Dimethoxy-benzyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

A. (2S, 2S)-N-(2, 4-dimethoxy-benzyl)-N-(2-hydroxy-propyl)-2-(2,2,2-trifluoroacetyl-amino)-propionamide.

To a slurry of (2S)-2-(2,2,2-trifluoroacetyl-amino)-propionic acid (15.3 g, 53.4 mmol) in 120 mL of methylene chloride is added triethylamine (5.6 mL, 40.0 mmol). The heterogeneous mixture is cooled to 0°C and isopropyl chloroformate (27 mL, 27.0 mmol) is added slowly. After stirring for 20 minutes at room temperature, a solution of the (2S)-1-(2,4-dimethoxy-benzyl-amino)-propan-2-ol (6.0 g, 26.7 mmol, obtained from the reductive amination of the corresponding aldehyde and aminoalcohol) in 5 mL of methylene chloride is added. The resulting mixture is left to stir overnight. Ethyl acetate (500 mL) is added, and the organic solution is washed with 1N hydrochloric acid (50 mL) and 1N sodium hydroxide (50 mL). The ethyl acetate is dried with magnesium sulfate, filtered and condensed. The resulting residue is chromatographed on silica gel (25% ethyl acetate/hexane) to give (2S, 2S)-N-(2,4-dimethoxy-benzyl)-N-(2-hydroxy-propyl)-2-(2,2,2-trifluoroacetyl-amino)-propionamide (6.29g, 60% yield) as a clear oil. MS $C_{17}H_{23}F_3N_2O_5$ MS m/z: 393.

B. (3S, 5R)-1-(2,4-dimethoxy-benzyl)-3,5-dimethyl-4-trifluoroacetyl-piperazin-2-one.

(2S, 2S)-N-(2,4-Dimethoxy-benzyl)-N-(2-hydroxypropyl)-2-(2,2,2-trifluoroacetyl-amino)-propionamide (3.64 g, 9.29 mmol) is dissolved in 25 mL of tetrahydrofuran. Triphenylphosphate (3.65 g, 14.0 mmol) is added, and the resulting mixture is cooled to 0 °C before diethyl azodicarboxylate (2.2 mL, 14 mmol) is added slowly. The resulting mixture is left to stir overnight. The reaction mixture is condensed, and the residue is purified by column chromatography (SiO₂, 25% ethyl acetate/hexane). The desired product, (3S, 5R)-1-(2,4-dimethoxy-benzyl)-3,5-dimethyl-4-trifluoroacetyl-piperazin-2-one (1.5 g, 43% yield), is isolated as a clear oil.

C. (3S, 5R)-1-(2,4-Dimethoxy-benzyl)-3,5-dimethyl-piperazin-2-one.

(3S, 5R)-1-(2,4-Dimethoxy-benzyl)-3,5-dimethyl-4-trifluoroacetyl-piperazin-2-one (575 mg, 1.54 mmol) is dissolved in 30 mL of methanol and 3 mL of H₂O. Potassium carbonate (883 mg, 6.4 mmol) is added to the solution, and the reaction is refluxed for one and half hours before concentration. Ethyl acetate (3x 50 mL) is used to extract the aqueous layer. Removal of
5 Ethyl acetate afforded the crude amine (387 mg, 91% yield) as a clear oil. C₁₅H₂₂N₂O₃ MS m/z: 279.

D. (2S, 6R)-4-(2,4-dimethoxy-benzyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

Triethylamine (0.4 mL, 2.8 mmol) and N-(benzyloxycarbonyloxy)-succinimide (1.04 g, 4.2 mmol) is added to a solution of the above crude amine (387 mg, 1.4 mmol) in 15 mL of
10 methylene chloride. The reaction mixture is left to stir overnight. The residue after concentration is chromatographed on silica gel (30% ethyl acetate/hexane) to give (2S, 6R)-4-(2,4-dimethoxy-benzyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (450 mg, 78 % yield) as a clear oil.

E. (2S, 6R)-2,6-Dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

(2S,6R)-4-(2,4-Dimethoxy-benzyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (1.13 g, 2.74 mmol) is dissolved in 20 mL of acetonitrile. An aqueous solution of potassium persulfate (2.2 g, 8.23 mmol) and sodium phosphate (2.3 g, 16.5 mmol) in 12 mL of H₂O is added, and the resulting mixture is heated to 95-100 °C for two hours. After cooling to room
20 temperature, ethyl acetate (200 mL) is used to extract the aqueous layer and dried over magnesium sulfate. The residue after filtration and concentration is chromatographed (SiO₂, 60% ethyl acetate/hexane) to give (2S, 6R)-2,6-Dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (480 mg, 67 % yield) as a yellow oil.

EXAMPLE 60. (2S, 6RS)-4-(4-chloro-quinolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

(2S,6RS)-2,6-Dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (380 mg, 1.45 mmol) is dissolved in 10 mL of THF and 1mL of DMF. Sodium hydride (60%, 72 mg, 3.14 mmol) is added at 0 °C and left to stir at room temperature for thirty minutes before 7-bromomethyl-4-chloro-quinoline (257 mg, 1.0 mmol) is added. The reaction is stirred for four
30 hours. Ethyl acetate is added to the mixture, and the reaction is quenched with 3 mL of H₂O. The two layers are separated and ethyl acetate (2x 30 ml) is used to extract before dried over magnesium sulfate. The residue after filtration and concentration is chromatographed on silica gel (60% EtOAc/Hexane) to give (2S, 6RS)-4-(4-chloro-quinolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (417 mg, 95 % yield). C₂₂H₂₀ClN₃O₃ MS m/z: 438, 440.

EXAMPLE 61. (3S,5RS)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one and

EXAMPLE 62. (3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one and

EXAMPLE 63 (3S, 5S)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one.

(2S, 6RS)-4-(4-Chloro-quinolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (417 mg, 1.0 mmol) is taken up in 7 mL of acetonitrile, and iodotrimethylsilane (0.43 mL, 3.0 mmol) is added. The resulting mixture is stirred for one hour at room temperature before quenched with methanol (1 mL). The residue after concentration is taken up in 2N hydrochloric acid (3 mL) and is extracted with ether (2x 30 mL). The aqueous layer is condensed to dryness and the residue is recrystallized from isopropanol and ether to give a mixture (1:4 ratio) of (3S, 5RS)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one as a yellow solid (290 mg). The two epimers are separated using a flash column (SiO₂, 1% triethylamine/3% methanol/methylene chloride). C₁₆H₁₈ClN₃O MS m/z: 304, 306. The minor isomer (3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one is (3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one while the major isomer is (3S, 5S)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one. Alternatively, (3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one and (3S, 5S)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one can be made via the same chemistry shown below from pure (2S, 6S)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester and (2S, 6RS)-4-(4-chloro-quinolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, respectively.

Alternative synthesis of (3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one.

A. (2S, 6R)-4-(4-chloro-quinolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

(2S, 6R)-2,6-Dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (750 mg, 2.86 mmol) is dissolved in 20 mL of THF and 2 mL of DMF. Sodium hydride (60%, 142.6 mg, 6.20 mmol) is added at 0 °C, and the reaction is left to stir at room temperature for thirty minutes at which time the 7-bromomethyl-4-chloro-quinoline (952 mg, 3.72 mmol) is added. The reaction is complete after stirring for four hours. Ethyl acetate (200 mL) is added to the mixture, and the reaction is quenched with 3 mL of H₂O. The two layers are separated, and ethyl acetate (2x 30 mL) is used to extract and dried over magnesium sulfate. The residue after filtration and concentration is chromatographed on silica gel (60% EtOAc/Hexane) to give (2S,6R)-4-(4-chloro-quinolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (1.04 g, 83 %).

B. (3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one.

A 33 % solution of hydrogen bromide in acetic acid (10 mL) is added to (2S,6R)-4-(4-chloro-quinolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (1.04 g, 2.38 mmol). The reaction is left to stir at room temperature for one hour. The reaction mixture is diluted with ethyl acetate and stirred vigorously to force the product to precipitate out of solution. The ethyl acetate is decanted off and the precipitate is purified on a silica gel column (1 % triethylamine/3 % methanol/methylene chloride) to 582 mg (81% yield) of (3S,5R)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one as a white solid.

10 EXAMPLE 64. (3S, 5S)-1-(4-chloro-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-piperazine-2-one and

EXAMPLE 65. (3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-piperazine-2-one.

The crude (3S,5RS)-1-(4-chloro-quinolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one (69 mg, 0.20 mmol) obtained from above is dissolved in 1 mL of DMF. Potassium carbonate (76 mg, 0.60 mmol) is added followed by the addition of 2-(3-bromopropenyl)-5-chloro-thiophene (56 mg, 0.24 mmol). The reaction is left to stir overnight. The potassium carbonate is filtered off, and the crude material is purified. The two epimers are separated at this stage by preparative thin layer chromatography (80 % EtOAc/hexane) to give a major epimer (3S, 5R)-1-(4-chloro-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-piperazine-2-one (25 mg, 26% yield) and a minor epimer (3S, 5S)-1-(4-chloro-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-piperazine-2-one (7 mg, 7.5% yield).

EXAMPLE 66. 4-(2-Oxopiperazin-1-ylmethyl)benzamidine.

A. 4-(4-Cyanobenzyl)-3-oxopiperazine-1-carboxylic acid benzyl ester.

25 To a solution of 3-oxo-piperazine-1-carboxylic acid benzyl ester (3.0 g, 12.8 mmol) and 4-bromomethyl tolylnitrile (2.76 g, 14.1 mmol) in 135 mL of THF and 15 mL of DMF at 0°C is added a 60% dispersion in mineral oil of NaH (0.49 g, 12.8 mmol). After 5 hours, the solution is diluted with saturated NH₄Cl and EtOAc. The organic layer is washed with H₂O and saturated NaCl. The organic layer is dried over MgSO₄, filtered and concentrated. The crude product is purified by column chromatography over silica gel eluting with 20% EtOAc/CH₂Cl₂. The title compound is obtained as a white solid (4.01 g, 11.4 mmol). ¹H NMR (CDCl₃, 300MHz) δ 7.62 (d, 2H), 7.39 (m, 7H), 5.14 (s, 2H), 4.68 (s, 2H), 4.27 (s, 2H), 3.73 (m, 2H), 3.30 (m, 2H).

B. 4-(4-Carbamimidoylbenzyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester.

35 A solution of 4-(4-cyanobenzyl)-3-oxopiperazine-1-carboxylic acid benzyl ester (2.4 g, 6.87 mmol) in 30mL of pyridine and 3 ml of Et₃N is saturated with H₂S. The resulting mixture is

sealed and stirred for 16 hours. After this time, the solution is concentrated. The residue is dissolved in 30 mL of acetone and methyl iodide (19.4 g, 137 mmol) is added. The solution is refluxed for 2 hours. After this time, the solution is concentrated. The residue is dissolved in MeOH (40 mL) and NH_4OAc (5.0 g, 65 mmol) is added. The solution is refluxed for 3 hours. After this time, the solution is concentrated. The crude product is purified by RP-HPLC eluting in a gradient of CH_3CN to 60% $\text{CH}_3\text{CN}/\text{H}_2\text{O}$ (0.1% TFA). The appropriate collected fractions are lyophilized to give the product as a white foam. MS (FAB) m/z 367, (M+H).

C. 4-(2-Oxopiperazin-1-ylmethyl)benzamidinium.

To a solution of 4-(4-carbamimidoylbenzyl)-3-oxopiperazine-1-carboxylic acid benzyl ester (2.0 g, 5.0 mmol) in 40 mL of MeOH and 4 mL of AcOH is added 10% Pd/C (0.4 g). The atmosphere above the reaction is replaced by hydrogen. After 4 hours, the solution is filtered through a pad of Celite. The organic layer is concentrated. The resulting crude product is purified by RP-HPLC eluting in a gradient of 10% $\text{CH}_3\text{CN}/\text{H}_2\text{O}$ (0.1% TFA) to 40% $\text{CH}_3\text{CN}/\text{H}_2\text{O}$ (0.1% TFA). The title compound is obtained as a white foam. ^1H NMR (d_6 -DMSO, 300 MHz) δ 9.3 (bs, 4H), 9.1 (bs, 2H), 7.83 (d, 2H), 7.42 (d, 2H), 4.78 (s, 2H), 3.80 (s, 2H), 3.44 (m, 2H), 3.32 (m, 2H).

EXAMPLE 67. 1-(2-Aminoquinolin-6-ylmethyl)piperazin-2-one.

A. 4-(2-Chloro-quinolin-6-ylmethyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester.

To a solution of 3-oxopiperazine-1-carboxylic acid benzyl ester (4.65 g, 19.8 mmol) and 6-bromomethyl-2-chloroquinoline (5.40 g, 21.0 mmol) in 80 mL of a 3:1 mixture of THF:DMF at 0°C is added sodium hydride (0.81 g, 20.2 mmol, 60% mineral oil dispersion). The resulting mixture is stirred for 1 hour at 0°C then at room temperature for 18 hours. The reaction mixture is quenched with saturated NH_4Cl solution, then diluted with EtOAc. The organic layer is washed sequentially with 1N HCl, water, saturated NaHCO_3 and saturated NaCl, then dried over MgSO_4 , filtered and concentrated. The crude product is triturated in Et_2O /hexanes/EtOAc and filtered to afford the title compound (6.96 g, 17.0 mmol) as a white solid. ^1H NMR (CDCl_3 , 300 MHz) δ 8.08 (d, 1H), 8.00 (d, 1H), 7.69 (s, 1H), 7.63 (dd, 1H), 7.41 (d, 1H), 7.35 (s, 5H), 5.15 (s, 2H), 4.78 (s, 2H), 4.28 (s, 2H), 3.70 (m, 2H), 3.32 (bs, 2H).

B. 4-(2-Phenoxyquinolin-6-ylmethyl)-3-oxopiperazine-1-carboxylic acid benzyl ester.

A mixture of phenol (15.1 g, 160 mmol) and 4-(2-chloroquinolin-6-ylmethyl)-3-oxopiperazine-1-carboxylic acid benzyl ester (6.60 g, 16.1 mmol) is melted together at 70°C until a homogeneous mixture is obtained. Potassium hydroxide (3.15 g, 56.1 mmol) is added and the resulting mixture is heated overnight at 120°C . After 24 hours, the brown/black residue is cooled to room temperature, diluted with CH_2Cl_2 and stirred with 1N NaOH (100 mL) for 30

minutes. The two layers are separated and the aqueous layer is extracted with CH_2Cl_2 . The combined organic layers are washed with 1N NaOH, saturated NaCl, dried over Na_2SO_4 , filtered and concentrated. The crude title compound (6.92 g, 14.8 mmol) is obtained as a beige foam and used in the subsequent step without further purification.

5 ^1H NMR (CDCl_3 , 300 MHz) δ 8.07 (d, 1H), 7.76 (d, 1H), 7.63 (s, 1H), 7.50 (dd, 1H), 7.42 (m, 2H), 7.34 (m, 6H), 7.25 (m, 2), 7.09 (d, 1H), 5.14 (s, 2), 4.75 (s, 2H), 4.27 (s, 2H), 3.66 (m, 2H), 3.30 (bs, 2H).

C. 4-(2-Aminoquinolin-6-ylmethyl)-3-oxopiperazine-1-carboxylic acid benzyl ester

A mixture of ammonium acetate (18.7 g, 242 mmol) and 4-(2-phenoxyquinolin-6-ylmethyl)-3-oxopiperazine-1-carboxylic acid benzyl ester (6.92 g, 14.8 mmol) is heated overnight at 150°C . After 21 hours, an additional 3 g of ammonium acetate is added and the heating is continued. After 5 hours, the mixture is cooled to room temperature, diluted with CH_2Cl_2 and stirred with 1N NaOH (100 mL) for 30 minutes. The two layers are separated and the aqueous layer is extracted with CH_2Cl_2 . The combined organic layers are washed with 1N
15 NaOH, saturated NaCl, dried over Na_2SO_4 , filtered and concentrated. The crude mixture of the title compounds (5.50 g, 14.1 mmol) is obtained as a beige foam and used in the subsequent step without further purification.

Major component (4-(2-aminoquinolin-6-ylmethyl)-3-oxopiperazine-1-carboxylic acid benzyl ester): ^1H NMR (CDCl_3 , 300 MHz) δ 7.86 (d, 1H), 7.63 (d, 1H), 7.48 (d, 1H), 7.45 (d, 1H),
20 7.35 (s, 5H), 6.74 (d, 1H), 5.14 (s, 2H), 4.79 (bs, 2H), 4.71 (s, 2H), 4.26 (s, 2H), 3.66 (s, 2H), 3.30 (s, 2H).

Minor component (3-oxo-4-(2-oxo-1,2-dihydroquinolin-6-ylmethyl)piperazine-1-carboxylic acid benzyl ester): ^1H NMR (CDCl_3 , 300 MHz) δ 7.75 (d, 1H), 7.48 (m, 2H), 7.37 (m, 6H), 6.70 (d, 1H), 5.14 (s, 2H), 4.66 (s, 2H), 4.26 (s, 2H), 3.66 (s, 2H), 3.30 (s, 2H).

25 D. 1-(2-Aminoquinolin-6-ylmethyl)piperazin-2-one.

To a solution of a mixture of 4-(2-aminoquinolin-6-ylmethyl)-3-oxopiperazine-1-carboxylic acid benzyl ester and 3-oxo-4-(2-oxo-1,2-dihydro-quinolin-6-ylmethyl)piperazine-1-carboxylic acid benzyl ester (5.50 g, 14.1 mmol) in 100 mL of 10:1 MeOH/HOAc is added a catalytic amount of 10% palladium on activated carbon. The heterogenous mixture is
30 hydrogenated at room temperature under a balloon of H_2 for 18 hours. The reaction mixture is filtered through a pad of Celite, washed with MeOH, and the filtrate is concentrated in vacuo. The crude mixture of products is purified by RP-HPLC eluting in a gradient of 2% $\text{CH}_3\text{CN}/\text{H}_2\text{O}$ (0.1% TFA) to 20% $\text{CH}_3\text{CN}/\text{H}_2\text{O}$ (0.1% TFA) and the appropriate product fractions are concentrated in vacuo to provide 1-(2-aminoquinolin-6-ylmethyl)-piperazin-2-one
35 ditrifluoroacetate (2.64 g, 5.45 mmol) as the major product in the form of a white solid. ^1H NMR

(d⁶-DMSO, 300 MHz) δ 8.78 (bs, 2H), 8.31 (d, 1H), 7.80 (s, 1H), 7.66 (m, 2H), 7.08 (d, 1H), 4.70 (s, 2H), 3.84 (s, 2H), 3.46 (bs, 4H). MS m/z 256, [M+]. Elemental analysis calculated with 0.25 mol of H₂O cal. C=44.25%, H=3.82%, N=11.47%, found C=44.23%, H=3.76%, N=11.23%.

The minor by-product 6-(2-oxo-piperazin-1-ylmethyl)-1H-quinolin-2-one (0.62 g, 1.28 mmol) is

also isolated from the RP-HPLC separation as a white solid ¹H NMR (d⁶-DMSO, 300 MHz) δ 11.76 (bs, 1H), 9.30 (bs, 2H), 7.85 (d, 1H), 7.55 (s, 1H), 7.42 (d, 1H), 7.28 (d, 1H), 6.50 (d, 1H), 4.60 (s, 2H), 3.80 (s, 2H), 3.38 (bs, 4H). MS m/z 257, [M+]. Elemental analysis calculated with 0.5 mol of H₂O cal. C=43.72%, H=3.68%, N=8.50%, found C=43.70%, H=3.62%, N=8.61%.

EXAMPLE 68. 1-(1-Aminoisoquinolin-6-ylmethyl)piperazin-2-one.

The title compound is prepared as described in EXAMPLE 67 substituting 6-bromomethyl-1-chloroisoquinoline for bromomethyl-2-chloroquinoline. ¹H NMR (d⁶-DMSO, 300 MHz) δ (9.18 (bs, 2H), 8.53 (d, 1H), 7.81 (s, 1H), 7.63 (m, 2H), 7.14 (d, 1H), 4.77 (s, 2H), 3.88 (s, 2H), 3.50 (m, 4H).

EXAMPLE 69. 2-(2-Oxopiperazin-1-ylmethyl)pyrrolo[3,2-c]pyridin-1-carboxylic acid tert-butyl ester.

A. 3-Iodopyridin-4-ylamine.

A solution of potassium iodide (19.48 g, 117.4 mmol) and iodine (18.37 g, 72.3 mmol) in water (77 mL) is added dropwise via an addition funnel to a refluxing solution of 4-aminopyridine (9.21 g, 97.8 mmol) and sodium carbonate (6.12 g, 57.7 mmol) in water (35 mL). Upon complete addition the mixture is stirred for 2 hours at reflux then cooled to room temperature and extracted with ethyl acetate. The combined organic layers are washed with saturated sodium thiosulfate solution (3x) and brine then dried over MgSO₄, filtered and concentrated to give the title product (8.37 g, 38.0 mmol) and a trace of the di-iodo compound as an yellow/orange solid. This material is used in the subsequent step without further purification. ¹H NMR (CDCl₃, 300 MHz) δ 8.70 (s, 1H), 8.10 (d, 1H), 6.55 (d, 1H), 4.60 (bs, 2H).

B. (3-Iodopyridin-4-yl)-carbamic acid tert-butyl ester.

Di-tert-butyl dicarbonate (20.7 g, 94.8 mmol) is added to a solution of 3-iodopyridin-4-ylamine (19.0 g, 86.4 mmol) in THF (86 mL). The resulting solution is stirred for 2 hours at room temperature then concentrated. The residue is diluted with ethyl acetate and washed with saturated sodium bicarbonate solution and brine. The organic layer is dried over MgSO₄, filtered and concentrated. The residue is purified by column chromatography eluting with 1% EtOAc/CH₂Cl₂ to give the title product and a small amount of the BOC-protected di-iodo compound. Trituration of the mixture with ether/hexane removes the undesired compound

leaving the title product in the solution. Filtration of the solid and concentration of the filtrate yields the title product (18.95 g, 59.2 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 8.75 (s, 1H), 8.35 (d, 1H), 8.1 (d, 1H), 7.0 (bs, 1H), 1.55 (s, 9H).

C. 3-Oxo-4-prop-2-ynylpiperazine-1-carboxylic acid benzyl ester.

Sodium hydride (0.82 g, 23.0 mmol, 60% mineral oil dispersion) is added to a solution of 4-benzyloxycarbonylpiperazin-2-one (5.13 g, 21.9 mmol) in THF/DMF (75 mL, 3/1 v/v) at 0°C. The mixture is stirred for 5 minutes, then propargyl bromide (3.7 mL, 41.5 mmol) is added dropwise. The resulting solution is stirred for 1 hour then brought to room temperature and stirred for 2 hours. The reaction is quenched with saturated ammonium chloride solution then diluted with ethyl acetate and washed with water (4x) and brine. The organic layer is dried over MgSO₄, filtered and concentrated to dryness. The residue is purified by column chromatography eluting with 5% MeOH/CH₂Cl₂ to give the product (5.96 g, 21.9 mmol) as a white solid. ¹H NMR (CDCl₃, 300 MHz) δ 7.3 (m, 5H), 5.12 (s, 2H), 4.25 (s, 2H), 4.16 (s, 2H), 3.75 (m, 2H), 3.47 (m, 2H), 2.22 (s, 1H).

D. 2-(4-Benzyloxycarbonyl-2-oxopiperazin-1-ylmethyl)pyrrolo[3,2-c]pyridin-1-carboxylic acid tert-butyl ester.

Pd(PPh₃)₂Cl₂ (0.29 g, 0.41 mmol), CuI (0.05 g, 0.25 mmol) and triethylamine (4.6 mL, 32.9 mmol) is added to a solution of 3-oxo-4-prop-2-ynylpiperazine-1-carboxylic acid benzyl ester (2.24 g, 8.23 mmol) and (3-iodopyridin-4-yl)-carbamic acid tert-butyl ester (2.63 g, 8.23 mmol) in DMF (30 mL) at room temperature. The mixture is heated to 100°C and stirred for 1.5 hours. The reaction mixture is then cooled to 50°C and DBU (2.5 mL, 16.5 mmol) is added. After 30 minutes the solution is cooled to room temperature, diluted with ethyl acetate and washed with saturated ammonium chloride, water and brine. The organic layer is dried over MgSO₄, filtered and concentrated in vacuo. The resulting solid is purified by column chromatography eluting with a gradient of 2% MeOH/CH₂Cl₂ to 5% MeOH/CH₂Cl₂ to give the product (2.93 g, 6.31 mmol) as a white solid. ¹H NMR (CDCl₃, 300 MHz) δ 8.75 (s, 1H), 8.4 (d, 1H), 7.85 (d, 1H), 7.35 (m, 5H), 6.38 (s, 1H), 5.2 (s, 2H), 5.00 (s, 2H), 4.29 (s, 2H), 3.85 (m, 2H), 3.52 (m, 2H), 1.7 (s, 9H). Ion spray MS, [M+H]⁺ = 465.

E. 2-(2-Oxopiperazin-1-ylmethyl)pyrrolo[3,2-c]pyridin-1-carboxylic acid tert-butyl ester.

Palladium black (1.1 g, 10.3 mmol) is added to a solution of 2-(4-benzyloxycarbonyl-2-oxo-piperazin-1-ylmethyl)pyrrolo[3,2-c]pyridin-1-carboxylic acid tert-butyl ester (1.7 g, 3.7 mmol) in HCO₂H/MeOH (45 mL, 4.4% solution). After 40 minutes the catalyst is filtered through Celite and washed with MeOH. The filtrate is concentrated in vacuo to remove methanol then the resulting solution is diluted with methylene chloride and washed with saturated sodium bicarbonate, and brine. The organic layer is dried over MgSO₄, filtered and concentrated to

dryness. The resulting solid is purified by column chromatography eluting with a gradient of 5% MeOH/CH₂Cl₂ to 10% MeOH/CH₂Cl₂ to give the product (0.8 g, 2.5 mmol) as a pale yellow foamy solid. ¹H NMR (CDCl₃, 300 MHz) δ 8.78 (s, 1H), 8.40 (d, 1H), 7.9 (d, 1H), 6.48 (s, 1H), 4.98 (s, 2H), 3.7 (s, 2H), 3.51 (t, 2H), 3.40 (t, 2H), 1.91 (bs, 1H), 1.70 (s, 9H).

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EXAMPLE 70. 2-(5-(+)-Methoxycarbonyl-2-oxo-piperazin-1-ylmethyl)-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester.

A. 2-Benzyloxycarbonylamino-3-(prop-2-ynylamino)-propionic acid methyl ester.

Propargyl bromide (1.6 mL, 14.4 mmol) is added to a solution of 3-amino-2-benzyloxycarbonylamino-propionic acid methyl ester hydrochloride (4.0 g, 13.9 mmol) and triethylamine (4.1 mL, 29.4 mmol) in THF (46 mL). The resulting mixture is heated to 50°C and stirred overnight then cooled to RT and concentrated in vacuo. The crude residue is diluted with methylene chloride, washed with saturated NaHCO₃ and brine then the organic layer is dried over MgSO₄, filtered and concentrated in vacuo. The crude material (4.0 g) is taken on to the subsequent step without further purification. ¹H NMR (CDCl₃, 300 MHz) δ 7.25-7.30 (m, 5H), 5.75 (bs, 1H), 5.20 (s, 2H), 4.45 (bs, 1H), 3.80 (s, 3H), 3.75 (m, 1H), 3.31 (s, 2H), 3.08 (dd, 1H), 2.98 (dd, 1H), 2.20 (t, 1H). EI MS, [M+H]⁺=291.

B. 2-Benzyloxycarbonylamino-3-(bromoactyl-prop-2-ynyl-amino)-propionic acid methyl ester.

DCC (2.27 g, 11.0 mmol) and bromoacetic acid (1.48 g, 10.7 mmol) is added to a solution of 2-benzyloxycarbonylamino-3-(prop-2-ynylamino)-propionic acid methyl ester (3.10 g, 10.7 mmol) in CH₂Cl₂ at RT. The mixture is stirred overnight then diluted with ether. The white solid which precipitates out is filtered and the filtrate is concentrated to give a yellow oil. The crude product is purified by chromatography eluting with a gradient of 40% EtOAc/hexanes to 50% EtOAc/hexanes to yield the title product (2.1g, 5.12 mmol) as an oil. ¹H NMR (CDCl₃, 300 MHz) δ 7.30 (m, 5H), 5.70 (d, 1H), 5.10 (s, 2H), 4.63 (m, 1H), 4.15 (d, 2H), 4.00 (m, 1H), 3.80 (s, 3H), 3.75 (s, 2H), 3.70 (dd, 1H), 2.27 (bs, 1H). Ion spray MS, [M+H]⁺=411, 413, Br pattern.

C. 5-Oxo-4-prop-2-ynyl-piperazine-1,2-dicarboxylic acid 1-benzyl ester 2-methyl ester.

Sodium hydride (0.20 mg, 4.9 mmol) is added to a solution of 2-benzyloxycarbonylamino-3-(bromoactyl-prop-2-ynyl-amino)-propionic acid methyl ester (2.0 g, 4.8 mmol) in THF (50 mL) at 0°C. The solution is stirred for 40 minutes then quenched with saturated NH₄Cl solution. The reaction mixture is concentrated in vacuo then diluted with CH₂Cl₂ and washed with brine. The organic layer is dried over , filtered and concentrated in vacuo. The crude product is purified by chromatography eluting with 50% EtOAc/hexanes to give the title product (1.4 g, 4.1 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 7.30 (m, 5H), 5.20 (s, 2H),

5.10 (m, 1H), 4.30 (dd, 1H), 4.25 (d, 2H), 4.08 (m, 1H), 4.00 (dd, 1H), 3.78 (dd, 1H), 3.78 (s, 3H), 2.25 (t, 1H).

D. 2-(5-(±)-Methoxycarbonyl-2-oxo-piperazin-1-ylmethyl)-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester.

¹H NMR (CDCl₃, 300 MHz) δ 8.75 (s, 1H), 8.41 (d, 1H), 7.90 (d, 1H), 6.42 (s, 1H), 5.00 (AB, 2H), 3.85-3.93 (m, 2H), 3.78 (s, 3H), 3.70-3.81 (m, 3H), 1.65 (s, 9H). Ion spray MS, [M+H]⁺=389.

EXAMPLE 71. 2-(2-(±)-Methoxycarbonyl-6-oxo-piperazin-1-ylmethyl)-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester.

¹H NMR (CDCl₃, 300 MHz) δ 8.81 (s, 1H), 8.43 (d, 1H), 7.90 (d, 1H), 6.48 (s, 1H), 5.63 (d, 1H), 4.40 (d, 1H), 4.20 (m, 1H), 3.78 (s, 3H), 3.70 (d, 1H), 3.52 (d, 1H), 3.33 (dd, 1H), 2.92 (s, 1H), 1.55 (s, 9H). Ion spray MS, [M+H]⁺=389.

EXAMPLE 72. 1-(4-Aminoquinazoline-7-ylmethyl)piperazine-2-one.

A. 4-(4-Chloroquinazoline-7-ylmethyl)-3-oxopiperazine-1-carboxylic acid tert-butyl ester.

To a solution of 3-oxopiperazine-1-carboxylic acid tert-butyl ester (3.93 g, 19.6 mmol) and 7-bromomethyl-4-chloroquinazoline, EXAMPLE 7, (5.0 g, 19.6 mmol) in 150 mL of THF and 15 mL of DMF at 0°C is added a 60% dispersion in mineral oil of NaH (0.79 g, 19.6 mmol). The solution is stirred at 0°C for 0.5 hours and then is allowed to warm to ambient temperature.

After 4 hours, the solution is poured into a saturated solution of NH₄Cl. The layers are separated and the organic layer is washed with H₂O, and saturated NaCl, dried over MgSO₄, filtered and concentrated. The title compound is obtained as a white solid (5.1 g, 13.4 mmol).

MS (FAB) m/z 377, 379, (M+H), chlorine pattern.

B. 4-(4-Aminoquinazoline-7-ylmethyl)-3-oxopiperazine-1-carboxylic acid tert-butyl ester.

A solution of 4-(4-chloroquinazoline-7-ylmethyl)-3-oxopiperazine-1-carboxylic acid tert-butyl ester (1.84 g, 4.9 mmol) in 120 mL of ethanol is saturated with NH₃ gas. To the resulting solution is added acetic acid (0.03 mL). The solution is heated to reflux. After 16 hours, the solution is concentrated. The resulting solid is dissolved in CH₂Cl₂ and the inorganic salts are filtered off. The organic solution is concentrated. The resulting solid is triturated with EtOAc. The title compound is obtained as a white solid (1.59 g, 4.5 mmol). MS (FAB) m/z 356, (M+H).

C. 1-(4-Aminoquinazoline-7-ylmethyl)piperazine-2-one.

A solution of 4-(4-aminoquinazoline-7-ylmethyl)-3-oxo-piperazine-1-carboxylic acid tert-butyl ester (1.92 g, 5.4 mmol) in EtOAc (200 mL) at 0 °C is saturated with HCl gas. The

solution is stirred at 0°C for 4 hours. After this time, the solution is concentrated. The title compound is obtained as a white solid (1.79 g, 5.4 mmol). ¹H NMR (d⁶-DMSO, 300 MHz) δ 9.9 (bs, 3H), 9.7 (bs, 2H), 8.8 (s, 1H), 8.46 (d, 1H), 7.72 (s, 1H), 7.61 (d, 1H), 4.78 (s, 2H), 3.83 (s, 2H), 3.4 (m, 4H).

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Example 73. 1-(4-Amino-thieno[2,3-d]pyrimidin-6-ylmethyl)-piperazin-2-one.

A. 1-(4-Amino-thieno[2,3-d]pyrimidin-6-ylmethyl)-3-oxo-piperazine-1-carboxylic acid tert-butyl ester.

10 The title compound is prepared as described in EXAMPLE 72, Part A, substituting 6-bromomethyl-4-chlorothieno[2,3-d]pyrimidine. for 7-bromomethyl-4-chloroquinazoline. Followed by treatment as described in EXAMPLE 72, Part B, the title compound is obtained. ¹H NMR (CD₃OD, 300 MHz) δ 8.22 (s, 1H), 7.35 (s, 1H), 5.48 (s, 2H), 4.10 (s, 2H), 3.60 (m, 2H), 3.40 (m, 2H), 1.45 (s, 9H). MS (ion spray), 364, (M+H).

15 B. 1-(4-Amino-thieno[2,3-d]pyrimidin-6-ylmethyl)-piperazin-2-one.

The title compound is obtained by treatment of 1-(4-amino-thieno[2,3-d]pyrimidin-6-ylmethyl)-3-oxo-piperazine-1-carboxylic acid tert-butyl ester as described in EXAMPLE 72, Part C. MS (EI), 2634, (M+).

20 EXAMPLE 74. 4-[3-(2-Oxo-piperazin-1-yl)-propyl]-piperidine-1-carboxylic acid tert-butyl ester.

A. 4-[3-(1-tert-butoxycarbonyl-piperidin-4-yl)-propyl]-3-oxo-piperazine-1-carboxylic acid benzyl ester.

The title compound is prepared as described in EXAMPLE 72, Part A, substituting 3-oxopiperazine-1-carboxylic acid benzyl ester for 3-oxopiperazine-1-carboxylic acid tert-butyl ester and 4-(3-bromopropyl)-piperidine-1-carboxylic acid tert-butyl ester for 7-bromomethyl-4-chloroquinazoline. The title compound is obtained as a white foam. ¹H NMR (CDCl₃, 300MHz) δ 7.38 (m, 5H), 5.12 (s, 2H), 4.18 (m, 4H), 3.73 (m, 2H), 3.33 (m, 4H), 2.66 (m, 2H), 1.58 (m, 6H), 1.42 (s, 9H), 1.38 (m, 3H).

B. 4-[3-(2-Oxo-piperazin-1-yl)-propyl]-piperidine-1-carboxylic acid tert-butyl ester.

30 4-[3-(1-tert-butoxycarbonyl-piperidin-4-yl)-propyl]-3-oxo-piperazine-1-carboxylic acid benzyl ester is treated as described in EXAMPLE 67, Part D, to give the title compound as an oil.

EXAMPLE 75. 1-(4-Amino-quinazoline-7-ylmethyl)-3-methoxymethyl-piperazine-2-one.

35 A. 2-Methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

To a solution of 2-oxo-3-(S)-methoxymethylpiperidine (5.36g, 19.3mmol), EXAMPLE 41, in 200mL of 10:1 THF:DMF is added 2-(benzhydrylidene-amino)-4-bromomethyl-benzonitrile (12.6g, 60%purity, 19.3mmol), prepared as in EXAMPLE 13. The solution is cooled to 0°C. To the solution is added NaH (0.77g of a 60% dispersion in mineral oil, 19.3mmol). The solution is stirred for 16 hours. After this time, 1N HCl is added until the pH=1. The solution is stirred for 1 hour. After this time, the solution is diluted with EtOAc. The organic layer is washed with water and sat. NaCl. The organic layer is dried over MgSO₄, filtered and concentrated under vacuum. The resulting crude product is purified by column chromatography eluting with a gradient of 20%EtOAc/CH₂Cl₂ to 40%EtOAc/CH₂Cl₂. The title compound (6.8g, 16.7mmol) is obtained as a white solid. ¹H NMR (CDCl₃, 300MHz) δ 7.34 (m, 5H), 6.61 (m, 2H), 5.13 (AB, 2H), 4.76 (m, 1H), 4.40 (AB, 2H), 4.08 (m, 5H), 3.74 (m, 2H), 3.32 (m, 1H), 3.30 (s, 3H), 3.10 (m, 1H).

B. 4-(4-Amino-quinazolin-7-ylmethyl)-2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

To a solution of 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (6.8g, 16.7mmol) in 100mL of ethanol is added triazine (2.2g, 26.4mmol) and acetic acid (1.6g, 26.4mmol). The solution is heated to a reflux. After 36h, the solution is concentrated. The resulting crude product is purified by column chromatography eluting with a gradient of 2%MeOH/CH₂Cl₂ to 5% MeOH/CH₂Cl₂. The title compound (5.8g, 13.3mmol) is obtained as a white solid. ¹H NMR (CDCl₃, 300MHz) δ 8.55 (s, 1H), 7.72 (m, 2H), 7.48 (m, 1H), 7.35 (m, 5H), 6.40 (bs, 2H), 5.16 (AB, 2H), 5.06 (m, 1H), 4.72 (m, 1H), 4.59 (m, 1H), 4.09 (m, 2H), 3.74 (m, 2H), 3.44 (m, 1H), 3.30 (s, 3H), 3.12 (m, 1H). MS (ion spray) m/z 436, (M+H).

C. 1-(4-Amino-quinazoline-7-ylmethyl)-3-methoxymethyl-piperazine-2-one.

To a solution of 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (5.8g, 13.3mmol) in 50mL of acetic acid is added dropwise, 20mL of a 30%HBr in AcOH solution. The solution is stirred for 1 hour. After this time, the solution is concentrated. The resulting crude product is purified by column chromatography eluting with CH₂Cl₂:MeOH:NH₄OH (20:5:1). The title compound (2.0g, 6.6mmol) is obtained as a white solid. ¹H NMR (d⁶-DMSO, 300MHz) δ 8.60 (s, 1H), 7.72 (m, 2H), 7.48 (d, 1H), 5.60 (bs, 2H), 4.72 (AB, 2H), 3.87 (m, 2H), 3.71 (m, 1H), 3.42 (m, 1H), 3.40 (s, 3H), 3.19 (m, 2H), 3.02 (m, 1H). MS (ion spray) m/z 302, (M+H).

EXAMPLE 76. 1-(4-Aminoquinazoline-7-ylmethyl)-3-butyl-piperazine-2-one.

The title compound is prepared as described in EXAMPLE 75, substituting 2-butyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 42, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. ¹H NMR (CD₃OD, 300MHz) δ 8.35 (s, 1H), 8.09 (d,

1H), 7.54 (s, 1H), 7.41 (d, 1H), 4.74 (s, 2H), 3.43 (m, 2H), 3.28 (m, 1H), 3.09 (m, 1H), 2.95 (m, 1H), 1.92 (m, 1H), 1.70 (m, 1H), 1.39 (m, 4H), 0.93 (m, 3H). MS (ion spray) m/z 314, (M+H).

EXAMPLE 77. 1-(4-Aminoquinazoline-7-ylmethyl)-3-ethyl-piperazine-2-one.

5 The title compound is prepared as described in EXAMPLE 75, substituting 2-ethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 43, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. ¹H NMR (CD₃OD, 300MHz) δ 8.36 (s, 1H), 8.11 (d, 1H), 7.57 (s, 1H), 7.42 (d, 1H), 4.78 (s, 2H), 3.40 (m, 2H), 3.29 (m, 1H), 3.11 (m, 1H), 2.98 (m, 1H), 2.00 (m, 1H), 1.77 (m, 1H), 1.20 (m, 3H). MS (ion spray) m/z 286, (M+H).

10 EXAMPLE 78. 1-(4-Aminoquinazoline-7-ylmethyl)-3-propyl-piperazine-2-one.

The title compound is prepared as described in EXAMPLE 75, substituting 2-propyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 44, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. ¹H NMR (CD₃OD, 300MHz) δ 8.36 (s, 1H), 8.13 (d, 1H), 7.60 (s, 1H), 7.47 (d, 1H), 4.78 (s, 2H), 3.44 (m, 2H), 3.30 (m, 1H), 3.11 (m, 1H), 2.97 (m, 1H), 1.98 (m, 1H), 1.72 (m, 1H), 1.50 (m, 2H), 0.97 (m, 3H). MS (ion spray) m/z 300, (M+H).

EXAMPLE 79. 1-(4-Amino-quinazoline-7-ylmethyl)-3-ethoxymethyl-piperazine-2-one.

20 The title compound is prepared as described in EXAMPLE 75, substituting 2-ethoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 45, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. ¹H NMR (CD₃OD, 300MHz) δ 8.34 (s, 1H), 8.07 (d, 1H), 7.53 (s, 1H), 7.40 (d, 1H), 4.79 (AB, 2H), 3.90 (m, 1H), 3.72 (m, 1H), 3.68 (m, 1H), 3.52 (m, 2H), 3.36 (m, 2H), 3.20 (m, 1H), 3.00 (m, 1H), 1.92 (m, 3H). MS (ion spray) m/z 316, (M+H).

25 EXAMPLE 80. 1-(4-Amino-quinazoline-7-ylmethyl)-3-methyl-piperazine-2-one.

The title compound is prepared as described in EXAMPLE 75, substituting 2-methyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 46, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. ¹H NMR (CD₃OD, 300MHz) δ 8.36 (s, 1H), 8.11 (d, 1H), 7.57 (s, 1H), 7.44 (d, 1H), 4.79 (AB, 2H), 3.58 (m, 1H), 3.47 (m, 1H), 3.31 (m, 1H), 3.12 (m, 1H), 3.00 (m, 1H), 1.41 (d, 3H). MS (ion spray) m/z 272, (M+H).

EXAMPLE 81. 1-(4-Amino-quinazoline-7-ylmethyl)-3-benzyl-piperazine-2-one.

35 The title compound is prepared as described in EXAMPLE 75, substituting 2-benzyl-3-oxo-piperazine-1-carboxylic acid benzyl, Example 47, ester for 2-methoxymethyl-3-oxo-

piperazine-1-carboxylic acid benzyl ester. ¹H NMR (CD₃OD, 300MHz) δ 8.35 (s, 1H), 8.09 (d, 1H), 7.57 (s, 1H), 7.38 (d, 1H), 7.27 (m, 5H), 4.74 (AB, 2H), 3.76 (m, 1H), 3.47 (m, 1H), 3.30 (m, 3H), 3.08 (m, 1H), 2.96 (m, 1H). MS (ion spray) m/z 348, (M+H).

5 EXAMPLE 82. 1-(4-Amino-quinazoline-7-ylmethyl)-3-(1-methoxyethyl)-piperazine-2-one.

The title compound is prepared as described in EXAMPLE 75, substituting 2-(1-methoxyethyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 48, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. This compound is isolated as the bis hydrobromide salt. ¹H NMR (CD₃OD, 300MHz) δ 8.70 (s, 1H), 8.40 (d, 1H), 7.88 (s, 1H), 7.71 (d, 1H), 4.94 (AB, 2H), 4.30 (m, 2H), 3.76 (m, 1H), 3.68 (m, 3H), 3.36 (s, 3H), 1.42 (d, 3H). MS (ion spray) m/z 316, (M+H).

15 EXAMPLE 83. 1-(4-Amino-quinazoline-7-ylmethyl)-3,3-dimethyl-piperazine-2-one.

The title compound is prepared as described in EXAMPLE 75, substituting 2,2-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 49, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. ¹H NMR (d⁶-DMSO, 300MHz) δ 8.34 (s, 1H), 8.12 (d, 1H), 7.72 (bs, 2H), 7.41 (s, 1H), 7.26 (d, 1H), 4.60 (s, 2H), 3.33 (m, 2H), 2.98 (m, 2H), 1.27 (s, 6H).

20 EXAMPLE 84. 1-(4-Amino-quinazoline-7-ylmethyl)-3-isopropyl-piperazine-2-one.

The title compound is prepared as described in EXAMPLE 75, substituting 2-isopropyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 50, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. ¹H NMR (d⁶-DMSO, 300MHz) δ 8.32 (s, 1H), 8.12 (d, 1H), 7.66 (bs, 2H), 7.42 (s, 1H), 7.27 (d, 1H), 4.60 (AB, 2H), 3.23 (m, 2H), 3.05 (m, 1H), 2.79 (m, 1H), 2.34 (m, 1H), 0.92 (s, 3H), 0.80 (s, 3H).

25 EXAMPLE 85. 1-(4-Amino-quinazoline-7-ylmethyl)-3-isobutyl-piperazine-2-one.

The title compound is prepared as described in EXAMPLE 75, substituting 2-isobutyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 51, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. ¹H NMR (d⁶-DMSO, 300MHz) δ 8.65 (s, 1H), 7.70 (m, 2H), 7.48 (m, 1H), 5.61 (m, 2H), 4.82 (m, 1H), 4.65 (m, 1H), 3.52 (dd, 1H), 3.37 (m, 1H), 3.18 (m, 2H), 2.98 (m, 1H), 1.92 (m, 1H), 1.76 (m, 1H), 1.59 (m, 2H), 0.95 (m, 6H).

30 EXAMPLE 86. 1-(4-Amino-quinazoline-7-ylmethyl)-3-(2-methoxyethyl)-piperazine-2-one.

The title compound is prepared as described in EXAMPLE 75, substituting 2-(2-methoxyethyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 52, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. ¹H NMR (d⁶-DMSO, 300MHz) δ 8.32 (s, 1H), 8.13 (d, 1H), 7.70 (bs, 2H), 7.42 (s, 1H), 7.28 (m, 1H), 4.60 (m, 2H), 3.32 (m, 8H), 3.11 (m, 1H), 2.95 (m, 1H), 2.78 (m, 1H), 2.07 (m, 1H), 1.72 (m, 1H).

EXAMPLE 87. 1-(4-Amino-quinazoline-7-ylmethyl)-3-methoxymethyl-6-methyl-piperazine-2-one.

The title compound is prepared as described in EXAMPLE 75, substituting 2-methoxymethyl-5-methyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, Example 53, for 2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester. ¹H NMR (CD₃OD, 300MHz) δ 8.72 (s, 1H), 8.32 (d, 1H), 7.78 (m, 2H), 5.11 (m, 1H), 4.81 (m, 1H), 4.42 (m, 1H), 4.13 (m, 1H), 4.04 (m, 1H), 3.74 (m, 2H), 3.52 (m, 1H), 3.43 (s, 3H), 1.34 (d, 3H).

EXAMPLE 88. (3S,5RS)-1-(4-amino-quinazolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one.

A. (2S,6RS)-4-[3-(benzhydryl-amino)-4-cyano-benzyl]-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

To a solution of the (2S,6RS)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (1.98 g, 7.56 mmol) in 20 mL of tetrahydrofuran and 2 mL of DMF is added sodium hydride (60%, 289 mg, 12.6 mmol) at 0°C. The reaction is stirred for one hour at room temperature and the 2-benzhydrylidene-amino-4-bromomethyl-benonitrile (4.24 mg, 11.34 mmol), Example 13, is added. After stirring at room temperature overnight, the tetrahydrofuran is removed. The residue is taken up in ethyl acetate. Excess sodium hydride is quenched with 5 mL of water, and normal aqueous work-up followed. The crude product is chromatographed on silica gel (50% EtOAc/Hexane) to give (2S,6RS)-4-[3-(benzhydryl-amino)-4-cyano-benzyl]-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (2.6 g, 65%). C₃₅H₃₂N₄O₃ MS m/z: 557.

B. (2S,6RS)-4-(3-amino)-4-cyano-benzyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

(2S,6RS)-4-[3-(Benzhydryl-amino)-4-cyano-benzyl]-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (2.6 g, 5.21 mmol) is dissolved in 100 mL of ethyl acetate and cooled to 0°C. A 12N solution of hydrochloric acid (0.5 ml, 6.0 mmol) is added dropwise. The deprotection is complete in thirty minutes. The reaction mixture is washed with 10 % sodium bicarbonate. The ethyl acetate layer is dried with magnesium sulfate, filtered and condensed. The resulting residue is purified by flash column (SiO₂, 60 % ethyl acetate/hexane) to give the

product (2S,6RS)-4-(3-amino)-4-cyano-benzyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (2.03 g, 99 %).

C. (2S,6RS)-4-(4-Amino-quinazolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester.

- 5 Glacial acetic acid (0.9 ml, 15.54 mmol) and 1,3,5-triazine (840 mg, 10.36 mmol) is added to a solution of (2S,6RS)-4-(3-amino-4-cyano-benzyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (2.03 g, 5.18 mmol) in ethanol. The resulting mixture is heated to reflux overnight. Replaced the ethanol with ethyl acetate and washed with saturated sodium bicarbonate (5 mL). The ethyl acetate layer is dried with magnesium sulfate, filtered and
- 10 condensed. The resulting residue is purified by flash column (SiO_2 , 20% methanol/methylene chloride) to give the product (2S,6RS)-4-(4-amino-quinazolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (1.85 g, 85%) as a yellow solid. $\text{C}_{23}\text{H}_{25}\text{N}_5\text{O}_3$ MS m/z: 420.

D. (3S,5RS)-1-(4-Amino-quinazolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one.

- 15 Palladium on carbon (10 %, 700 mg) is added to a solution of (2S,6RS)-4-(4-amino-quinazolin-7-ylmethyl)-2,6-dimethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester (1.62 g, 3.87 mmol) in 20 mL of methanol and 2 mL of acetic acid. The reaction mixture is left to stir in an atmosphere of hydrogen for eight hours. The palladium is filtered off, and the volatile solvents are removed on the rotovap. The crude product (1.7 g, 95 %) is isolated as a white
- 20 solid. The two epimers are separated on silica gel (1% triethylamine/15% methanol/methylene chloride). The minor epimer is assigned as (3S,5R)-1-(4-amino-quinazolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one and the major epimer is assigned as (3S,5S)-1-(4-amino-quinazolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one.

25 EXAMPLE 89. 1-(4-Chloroquinolin-7-ylmethyl)-piperazin-2-one.

- 4-(Benzyloxycarbonyl)-piperazin-2-one (1.1 g, 4.6 mmol) is dissolved in THF (50 mL), cooled in an ice bath and treated with tetrabutylammonium iodide (0.18 g, mmol) and 60% sodium hydride (0.24 g, 6.0 mmol). The reaction mixture is stirred at 0 C for 30 minutes then treated dropwise with a solution of 7-bromomethyl-4-chloroquinoline (1.2 g, 4.6 mmol),
- 30 Example 14, in THF (50 mL). The resulting solution is stirred at 0 C for 2 h then quenched with ammonium chloride solution and concentrated. Dilution with ethyl acetate is followed by a water wash; the organic layer is dried (sodium sulfate) and concentrated. The residue is chromatographed (4% methanol/methylene chloride) to yield solid
- 35 4-(benzyloxycarbonyl)-1-(4-chloroquinolin-7-ylmethyl)-piperazin-2-one (1.2 g, 2.9 mmol). A portion of this material (0.75 g, 1.8 mmol) is dissolved in acetonitrile (20 mL) and treated with

iodo trimethylsilane (0.78 mL, 5.4 mmol) at room temperature for 3 hours. The reaction is quenched with methanol and concentrated to dryness. Methanol addition and concentration is repeated four times. The final residue is taken up in 2M aqueous HCl; the solution is washed with ether and concentrated. The residue is recrystallized from isopropanol and ether to yield the title compound (0.63 g, 2.3 mmol) MS m/z: $M^+ = 275$; $^1\text{H NMR}$ (CD_3OD , 300 MHz) δ 9.1 (d, 1H), 8.5 (d, 1H), 8.2-8.3 (m, 2H), 8.0 (d, 1H), 5.2 (s, 2H), 4.1 (s, 2H), 3.7-3.8 (m, 2H), 3.6-3.7 (m, 2H).

EXAMPLE 90. 1-(4-Chlorocinnolin-7-ylmethyl)-piperazin-2-one.

4-(*t*-Butyloxycarbonyl)-piperazin-2-one (0.6 g, 3.0 mmol), EXAMPLE 40, is dissolved in THF (80 mL), cooled in an ice bath and treated with tetrabutylammonium iodide (0.23 g, 0.62 mmol) and 60% sodium hydride (0.12 g, 3.0 mmol). The reaction mixture is stirred at 0°C for 40 minutes then treated dropwise with a solution of 7-bromomethyl-4-chlorocinnoline (10.7g, 2.7 mmol), Example 15, in THF (20 mL). The resulting solution is warmed to ambient temperature over 2 hours. The solution is evaporated to dryness and the residue is taken up in ethyl acetate and 10 % aqueous sodium bicarbonate solution. The organic layer is separated, washed with water, dried (sodium sulfate) and concentrated. The residue is chromatographed (ethyl acetate) to yield the title compound (0.6 g, 1.6 mmol). A portion of this material (0.21 g, 1.26 mmol) is dissolved in THF (~ 4 mL) and treated with a saturated solution of HCl in ethyl acetate (50 mL) at room temperature for 2 hours. The solution is filtered and concentrated to a residue (0.14 g, 0.4 mmol). MS m/z: $M^+ = 275$; $^1\text{H NMR}$ (CD_3OD , 300 MHz) δ 9.15 (d, 1H), 8.5 (d, 1H), 8.25 (s, 1H), 8.15 (d, 1H), 8.0 (d, 1H), 5.0 (s, 2H), 4.1 (s, 2H), 3.7-3.8 (m, 2H), 3.6-3.7 (m, 2H).

EXAMPLE 91. 1-(4-Chloroquinolin-7-ylmethyl)-3-(S)-methylpiperazin-2-one.

4-(Benzyloxycarbonyl)-3-(S)-methylpiperazin-2-one (1.0 g, 4.0 mmol), EXAMPLE 46, is dissolved in THF (60 mL), cooled in an ice bath and treated with tetrabutylammonium iodide (0.10 g, 0.27 mmol) and 60% sodium hydride (0.18 g, 4.4 mmol). The reaction mixture is stirred at 0°C for 30 minutes then treated dropwise with a solution of 7-bromomethyl-4-chloroquinoline (1.12 g, 4.4 mmol), EXAMPLE 14, in THF (5 mL). The resulting solution warmed to room temperature over approximately 1 h then quenched with sodium bicarbonate solution and concentrated. The residue is partitioned between ethyl acetate and water; the organic layer is dried (sodium sulfate) and concentrated. The residue is chromatographed (5 % methanol/methylene chloride) to yield solid 4-(Benzyloxycarbonyl)-1-(4-chloroquinolin-7-ylmethyl)-3-(S)-methyl-piperazin-2-one (1.32 g, 3.1 mmol). A portion of this material (0.10 g, 0.23 mmol) is dissolved in acetonitrile (6 mL) and treated with iodotrimethyl-silane (0.1 mL, 0.75

mmol) at room temperature for 2 hours. The reaction is quenched with methanol and concentrated to dryness. Methanol addition and concentration is repeated six times. The final residue is taken up in 2M aqueous HCl; the solution is washed with ether and concentrated to yield the title compound. MS m/z: $M^+ = 289$; ^1H NMR (CD_3OD , 300 MHz) δ 9.2 (d, 1H), 8.6 (d, 1H), 8.2-8.3 (m, 2H), 8.0 (d, 1H), 5.1 (q, 1H), 4.3-4.4 (m, 1H), 3.8-4.0 (m, 2H), 3.6-3.8 (m, 3H), 1.75 (d, 3H).

EXAMPLE 92. 1-[2-(Pyridin-4-ylamino)-ethyl]-piperazin-2-one.

A. 4-(tert-Butyloxycarbonyl)-1-(2-aminoethyl)-piperazin-2-one.

4-(tert-Butyloxycarbonyl)-piperazin-2-one (8.0 g, 40 mmol), EXAMPLE 40, is dissolved in THF (160 mL), cooled in an ice bath and treated with 60 % sodium hydride (1.9 g, 48 mmol). The reaction mixture is stirred 40 minutes, then treated with tetra-butylammonium iodide (0.35 g, 0.95 mmol) and bromoacetonitrile (3.4 mL, 48 mmol). After 2 h the reaction is quenched with water, concentrated to a small volume and extracted with methylene chloride (3 X). The combined organic extracts are concentrated and the residue is chromatographed (50 % ethyl acetate/hexane) to give 4-(tert-butyloxycarbonyl)-1-cyanomethyl-piperazin-2-one (5.2 g, 21.7 mmol). This material is dissolved in ethanol (140 mL) and treated with platinum oxide (0.83 g) at 50 PSI of hydrogen gas for 24 hours. The catalyst is removed by filtration and the solution is concentrated to yield 4-(tert-butyloxycarbonyl)-1-(2-aminoethyl)-piperazin-2-one (5.2 g, 21.6 mmol). ^1H NMR (CDCl_3 , 300 MHz) δ 4.08 (s, 2H), 3.62 (m, 2H), 3.44 (t, 2H), 3.38 (t, 2H), 2.89 (t, 2H).

B. 4-(tert-Butyloxycarbonyl)-1-[2-(2,3,5,6-tetrachloropyridin-4-ylamino)-ethyl]-piperazin-2-one.

4-(tert-Butyloxycarbonyl)-1-(2-aminoethyl)-piperazin-2-one (4.0 g, 16 mmol) is dissolved in methylene chloride (150 mL) and treated with 4-nitro-2,3,5,6-tetrachloro-pyridine (4.8 g, 18 mmol) and N-methylmorpholine (4.0 mL, 36 mmol). The reaction mixture is stirred for 5 h, concentrated and the residue is purified by chromatography (50% ethyl acetate/hexane) to give the title compound (4.8 g, 10.5 mmol). Fab MS m/z: 457, 469, 461, $[M+1]^+$; ^1H NMR (CDCl_3 , 300 MHz) δ 6.00 (t, 1H), 4.10 (s, 2H), 3.97 (m, 2H), 3.66 (m, 2H), 3.38 (m, 2H).

C. 1-[2-(Pyridin-4-ylamino)-ethyl]-piperazin-2-one.

4-(tert-Butyloxycarbonyl)-1-[2-(2,3,5,6-tetrachloropyridin-4-ylamino)-ethyl]-piperazin-2-one (3.5 g, 7.6 mmol) is dissolved in methanol (20 mL) and 0.5 M sodium methoxide in methanol (150 mL, 75 mmol). The solution is treated with Pd/C (0.5 g) and agitated under 50 PSI of hydrogen gas for 16 hours. The solvent is removed and the residue is extracted with methylene chloride which is filtered. The filtrate is concentrated and loaded onto a silica flash column. The column is eluted with 5% MeOH/ CH_2Cl_2 followed by $\text{NH}_4\text{OH}/\text{MeOH}/\text{CH}_2\text{Cl}_2$ (1:5:95)

and $\text{NH}_4\text{OH}/\text{MeOH}/\text{CH}_2\text{Cl}_2$ (1:10:70) to yield 4-(tert-Butyloxycarbonyl)-1-[2-(pyridin-4-ylamino)-ethyl]-piperazin-2-one as a white foam (1.5 g, 4.7 mmol). This material (1.5 g, 4.7 mmol) is treated with 20% trifluoroacetic acid in methylene chloride (110 mL) at ambient temperature for 2 hours. The solution is concentrated and the residue is treated with saturated bicarbonate solution and ammonium hydroxide until a basic solution is obtained. The solution is applied to a silica column and eluted with $\text{NH}_4\text{OH}/\text{MeOH}/\text{CH}_2\text{Cl}_2$ (1:10:60) and 1-[2-(pyridin-4-ylamino)-ethyl]-piperazin-2-one is isolated as a mixture of desired product and inorganic salts (estimate 25 % by weight) EI MS m/z: 220, M^+ ; ^1H NMR (CD_3OD , 300 MHz) δ 8.07 (d, 2H), 6.96 (d, 2H), 3.77 (s, 2H), 3.65 (m, 6H), 3.44 (t, 2H).

EXAMPLE 93. 1-[2-((Methyl)-(pyridin-4-yl)-amino)-ethyl]-piperazin-2-one trifluoroacetate.

4-(tert-Butyloxycarbonyl)-1-[2-(2,3,5,6-tetrachloropyridin-4-ylamino)-ethyl]-piperazin-2-one (0.19 g, 0.41 mmol), Example 92, Part B, is dissolved in DMF (3 ml) and treated with 60 % NaH (20 mg, 0.5 mmol). After 10 minutes methyl iodide (0.025 ml, 0.40 mmol) is added and the yellow solution is stirred at r.t. overnight. The solution is diluted with EtOAc and washed with H_2O (6 X). The organic layer is dried (MgSO_4) and concentrated to a residue (0.19 g, 0.40 mmol). The residue is dissolved in methanol (2 ml) and treated with 0.5 M NaOMe in MeOH (8 ml, 4.0 mmol). The solution is treated with Pd/C and agitated under 60 PSI of hydrogen gas overnight and filtered. The filtrate is concentrated and extracted several times with CH_2Cl_2 ; removal of solvent in vacuo gives 4-(tert-Butyloxycarbonyl)-1-[2-((methyl)-(pyridin-4-yl)-amino)-ethyl]-piperazin-2-one as an amorphous residue (0.16 g). EI MS m/z: 335, $[\text{M}+1]^+$; ^1H NMR (CDCl_3 , 300 MHz) δ 8.21 (d, 2H), 6.56 (d, 2H), 3.99 (s, 2H), 3.60 (t, 2H), 3.53 (t, 2H), 3.47 (t, 2H), 3.28 (t, 2H), 2.98 (s, 3H), 1.46 (s, 9H). Treatment of the above product with 20% TFA/ CH_2Cl_2 (10 mL) at r.t. for 1 h gives, after concentration, the title compound as a residue which is used without further purification. ^1H NMR (CD_3OD , 300 MHz) δ 8.14 (d, 2H), 7.30 (br, 1H), 7.00 (br, 1H), 3.88-3.67 (m, 8H), 3.53 (t, 2H), 2.26 (s, 3H).

EXAMPLE 94. 1-[2-(3-Methylpyridin-4-yl-amino)-ethyl]-piperazin-2-one.

A. 4-[2-(3-Methylpyridin-4-ylamino)-ethyl]-3-oxo-piperazine-1-carboxylic acid benzyl ester.

4-(Benzyloxycarbonyl)-piperazin-2-one (4.7 g, 20 mmol) is dissolved in THF (50 mL) and treated with 1.5M LDA (20 mL, 30 mmol) at 0°C . The reaction mixture is treated with condensed ethylene oxide (3 mL, 40 mmol) and stirred at r.t. overnight. The mixture is neutralized with 2N HCl, concentrated, and extracted with EtOAc. The EtOAc layer is washed with H_2O and concentrated to a crude residue. Further extraction of the crude with Et_2O and

concentration of the ethereal layer gives an oil (1.5 g). The above oil is dissolved in CH_2Cl_2 (25 mL) and added to the solution of 2M oxalyl chloride (7.5 mL, 15 mmol) and DMSO (2.3 mL, 29.7 mmol) in CH_2Cl_2 (25 mL) at -60°C . After 15 minutes, Et_3N (2.1 mL, 15 mmol) is added. The mixture is stirred at -50°C for 10 minutes then warmed to r.t for 10 minutes. The reaction is quenched with 0.5 N HCl and extracted with CH_2Cl_2 . The CH_2Cl_2 layer is washed with 0.5 N HCl, brine (2 X), H_2O , and concentrated to a residue. The residue is purified by chromatography (2% MeOH/ CH_2Cl_2) to give 4-amino-3-methyl pyridine as an oil (0.5 g, 1.6 mmol). A solution of the oil (0.2 g, 2 mmol), and (1R)-(-)-10-camphorsulfonic acid (15 mg) in toluene (100 mL) is refluxed with a Dean Stark set up overnight. The mixture is concentrated and the residue is purified by chromatography (2-4% MeOH/ CH_2Cl_2) to give the title imine as a white foam (0.20 g, 0.54 mmol). Ion spray MS m/z : 367, $[M+1]^+$; ^1H NMR (CDCl_3 , 300 MHz) δ 8.20 (d, 1H), 8.14 (s, 1H), 7.35 (s, 5H), 6.60 (d, 1H), 6.18 (dd, 1H), 5.15 (s, 2H), 4.97 (d, 1H), 4.30 (s, 2H), 3.78 (t, 2H), 3.50 (bm, 2H), 2.15 (s, 3H).

B. 1-[2-(3-Methylpyridin-4-yl-amino)-ethyl]-piperazin-2-one.

4-[2-(3-Methylpyridin-4-ylimino)-ethyl]-3-oxo-piperazine-1-carboxylic acid benzyl ester (0.20 g, 0.54 mmol) is dissolved in anhydrous ethanol (20 mL) and hydrogenated at 50 PSI with 10% Pd/C overnight. After filtration, the filtrate is concentrated. The residue is treated with Pd black in 5% $\text{HCO}_2\text{H}/\text{CH}_2\text{Cl}_2$ (10 mL) for 10 minutes. Filtration and concentration gives crude residue, which is purified by chromatography using $\text{NH}_4\text{OH}/\text{MeOH}/\text{CH}_2\text{Cl}_2$ (1:5:95) to give the title compound as a clear syrup (0.078 g, 0.33 mmol). ^1H NMR (CDCl_3 , 300 MHz) δ 8.17 (d, 1H), 8.03 (s, 1H), 7.35 (s, 5H), 6.36 (d, 1H), 5.30 (b, 1H), 3.74 (t, 2H), 3.53 (s, 2H), 3.38 (m, 4H), 3.08 (t, 2H), 2.02 (s, 3H).

EXAMPLE 95. 1-[2-(Pyridazin-4-ylamino)-ethyl]-piperazin-2-one.

1-(2-Aminoethyl)-4-(tert-butyloxycarbonyl)-piperazin-2-one from EXAMPLE 92, Part A (1.0 g, 4.1 mmol) is treated with 3,4,5-trichloropyridazine (0.81 g, 4.1 mmol), triethylamine (0.57 mL, 4.1 mmol), THF (25 mL) and heated to 120°C in a sealed tube for 3 hours. Upon cooling, the solution is diluted with ethyl acetate and washed with aqueous sodium bicarbonate (25 mL), water and dried over sodium sulfate. The organic layer is concentrated and chromatographed (5% methanol/methylene chloride) to give a mixture of isomers (0.8 g, 20 mmol). The mixture is dissolved in 0.5 M sodium methoxide in methanol (200 mL), treated with 10% Pd/C (0.5 g) and agitated under 50 PSI of hydrogen for 20 hours. The reaction mixture is filtered; the filtrate is concentrated to a residue which is chromatographed ($\text{NH}_4\text{OH}/\text{H}_2\text{O}/\text{MeOH}/\text{EtOAc}$, 1:1:2:90) to give crude 4-(tert-butyloxycarbonyl)-1-[2-(pyridazin-4-ylamino)-ethyl]-piperazin-2-one. This material is dissolved in a minimal amount of THF and treated with a saturated solution of HCl in

ethyl acetate (50 mL). The solution is stirred at ambient temperature for 2 h and diluted with diethyl ether (50 mL). The precipitated title compound is collected and air dried (0.5 g, 1.7 mmol). MS m/z: 367, [M+1]⁺; ¹H NMR (CD₃OD, 300 MHz) δ 8.8 (d, 1H), 8.5 (s, 1H), 7.4 (d, 1H), 4.1 (s, 2H), 3.5-3.8 (m, 8H).

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EXAMPLE 96. 4-[3-(4-tert-Butoxycarbonylamino-pyridin-3-yl)-propenyl]-3-oxo-piperazine-1-carboxylic acid tert-butyl ester and 4-[3-(4-tert-butoxycarbonylamino-pyridin-3-yl)-allyl]-3-oxo-piperazine-1-carboxylic acid tert-butyl ester.

A. 1-Allyl-4-(tert-butyloxycarbonyl)-piperazin-2-one.

10 4-(tert-Butyloxycarbonyl)-piperazin-2-one (1.0 g, 5.0 mmol), EXAMPLE 40, is alkylated with allyl bromide (0.48 ml, 5.5 mmol) in THF (20 ml) using the procedure described in Example 92, Part A. The title compound (0.92 g, 3.8 mmol) is obtained as a colorless liquid after chromatographed (50 % ethyl acetate/hexane). EI MS m/z 240 (M⁺); ¹H NMR (CDCl₃, 300 MHz) δ 5.80-5.68 (m, 1H), 5.23-5.15 (m, 2H), 4.09 (s, 2H), 4.03 (d, 2H), 3.63 (t, 2H), 3.30 (t, 15 2H), 1.45 (s, 9H).

B. 4-[3-(4-tert-Butoxycarbonylamino-pyridin-3-yl)-propenyl]-3-oxo-piperazine-1-carboxylic acid tert-butyl ester and 4-[3-(4-tert-butoxycarbonylamino-pyridin-3-yl)-allyl]-3-oxo-piperazine-1-carboxylic acid tert-butyl ester

1-Allyl-4-(tert-butyloxycarbonyl)-piperazin-2-one (0.49 g, 2.0 mmol) is treated with (3-iodo-pyridin-4-yl)-carbamic acid tert-butyl ester (0.64 g, 2.0 mmol), Pd(OAc)₂ (14 mg, 0.06 mmol), P(o-tol)₃ (37 mg, 0.12 mmol), and Et₃N (0.56 mmol) in a seal tube. The mixture is stirred at 100 °C overnight, then diluted with CH₂Cl₂ and washed H₂O (2 X). The CH₂Cl₂ layer is concentrated and the residue is chromatographed (5% MeOH/CH₂Cl₂) to give a mixture of two isomers (0.40 g, 0.92 mmol). The mixture is separated into its constituent isomers upon further chromatography (EtOAc) to give 4-[3-(4-tert-butoxycarbonylamino-pyridin-3-yl)-propenyl]-3-oxo-piperazine-1-carboxylic acid tert-butyl ester (90 mg, 0.21 mmol, higher R_f value) and 4-[3-(4-tert-butoxycarbonylamino-pyridin-3-yl)-allyl]-3-oxo-piperazine-1-carboxylic acid tert-butyl ester (0.24 g, 0.56 mmol, lower R_f value). For the former: MS m/z 433 (M+1); ¹H NMR (CDCl₃, 300 MHz) δ 8.38 (d, 1H), 8.28 (s, 1H), 7.93 (d, 1H), 7.48 (d, 1H), 6.67 (s, 1H), 5.10 (m, 1H), 4.15 (s, 2H), 3.70 (t, 2H), 3.46 (t, 2H), 3.39 (d, 2H), 1.48 (s, 9H), 1.45 (s, 9H). For the latter: MS m/z 433 (M+1); ¹H NMR (CDCl₃, 300 MHz) δ 8.39 (s, 1H), 8.37 (d, 1H), 7.98 (d, 1H), 6.77 (s, 1H), 6.52 (d, 1H), 6.07 (m, 1H), 4.23 (d, 2H), 4.12 (s, 2H), 3.69 (t, 2H), 3.40 (t, 2H), 1.52 (s, 9H), 1.45 (s, 9H).

EXAMPLE 97. 4-[3-(4-tert-Butoxycarbonylamino-pyridin-3-yl)-propyl]-3-oxo-piperazine-1-carboxylic acid tert-butyl ester

A mixture of the two isomers from EXAMPLE 96, Part B. (0.11 g, 0.25 mmol) is dissolved in MeOH (7 ml), treated with with 10% Pd/C and is stirred under a balloon of hydrogen for 4 hours. Filtration and concentration gives a white foam (80 mg, 0.18 mmol). EI MS m/z 434 (M+); ¹H NMR (CDCl₃, 300 MHz) δ 8.33 (d, 1H), 8.30 (s, 1H), 8.05 (d, 1H), 4.08 (s, 2H), 3.64 (t, 2H), 3.50 (t, 2H), 3.35 (t, 2H), 2.58 (t, 2H), 1.90 (m, 2H), 1.57 (s, 9H), 1.48 (s, 9H).

EXAMPLE 98. 4-(Benzyloxycarbonyl)-1-(2-pyrrolo[3,2-c]pyridin-1-ylethyl)-piperazin-2-one

4-(Benzyloxycarbonyl)-1-(2-hydroxyethyl)-piperazin-2-one, prepared as described in EXAMPLE 94, part A. (0.26 g, 0.94 mmol) in methylene chloride (6 mL) is treated with triphenyl phosphine (0.60 g, 2.3 mmol), imidazole (0.16 g, 2.3 mmol), and iodine (0.47 g, 1.9 mmol) for 0.5 h at 0 °C. The reaction mixture is partitioned between water and methylene chloride; the organic layer is concentrated and the residue is chromatographed (15 % EtOAc/ methylene chloride) to give 4-(benzyloxycarbonyl)-1-(2-iodoethyl)-piperazin-2-one (0.24 g, 0.62 mmol). Pyrrolo[3,2-c]pyridine (0.073 g, 0.62 mmol) is dissolved in DMF (3 mL) and treated with 60 % sodium hydride (0.03 g, 0.74 mmol) and all of the 4-(benzyloxycarbonyl)-1-(2-iodoethyl)-piperazin-2-one from the previous step; the reaction mixture is stirred at r.t. for 16 g. The reaction mixture is concentrated to dryness and the residue is partitioned between water and methylene chloride. The organic layer is concentrated and subjected to chromatography (2-5 % MeOH/methylene chloride) to yield the title compound (0.028 g, 0.074 mmol) Ion Spray MS m/z: 379, [M+1]⁺.

EXAMPLE 99. (±)-1-(3-Amino-4-cyano-benzyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-carboxylic acid methyl ester.

A. (±)-1-[3-(Benzhydrylidene-amino)-4-cyano-benzyl]-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-carboxylic acid methyl ester

A solution containing (±)-1-[3-(benzhydrylidene-amino)-4-cyano-benzyl]-6-oxo-piperazine-2-carboxylic acid methyl ester (55 mg, 0.12 mmol) in CH₂Cl₂ (1 mL) is cooled to 0°C.

DIPEA (24 mg, 0.18 mmol) is then added followed by the addition of 6-chloro-benzo[b]thiophene-2-sulfonyl chloride (32 mg, 0.12 mmol), EXAMPLE 1. The reaction mixture is warmed to ambient temperature. After 16 h, the reaction mixture is absorbed directly onto silica gel and chromatographed (CH₂Cl₂ to 2% MeOH/ CH₂Cl₂) to provide 60 mg (73%) of the title compound. ¹H NMR (300 MHz, CDCl₃) δ 2.77 (dd, J = 12.3, 3.4 Hz, 1H), 3.50-3.72 (m, 3H), 3.79 (s, 3H), 4.15 (dd, J = 12.3, 1.4 Hz, 1H), 4.24 (d, J = 16.9 Hz, 1H), 5.41 (d, J = 15.3 Hz,

1H), 6.50 (s, 1H), 6.76 (dd, J = 7.9, 1.4 Hz, 1H), 7.11-7.86 (m, 15H) ppm; MS (ISP loop): m/z 683 (M+H).

B. (±)-1-(3-Amino-4-cyano-benzyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-carboxylic acid methyl ester

- 5 Concentrated HCl (12M, one drop) is added at 0°C to a mixture containing (±)-1-[3-(benzhydrylidene-amino)-4-cyano-benzyl]-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-carboxylic acid methyl ester (60 mg, 0.08 mmol) in MeOH (5 mL). Added THF (2 mL) followed by a second drop of 12M HCl and warmed reaction mixture to ambient temperature. The reaction is quenched by pouring the reaction mixture onto a 1:1 mixture of
- 10 CH₂Cl₂/aqueous NaHCO₃ and the layers are separated. The aqueous phase is washed with CH₂Cl₂ and then the combined organic phase is washed with brine, dried over anhydrous MgSO₄, filtered and concentrated. The crude residue is chromatographed on silica gel (CH₂Cl₂ to 4% MeOH/ CH₂Cl₂) to provide 42 mg (93%) of the title compound. ¹H NMR (300 MHz, CDCl₃) δ 2.98 (dd, J = 12.5, 3.5 Hz, 1H), 3.60 (d, J = 16.8 Hz, 1H), 3.69 (d, J = 15.3 Hz, 1H),
- 15 3.79 (s, 3H), 3.98 (m, 1H), 4.21-4.31 (m, 2H), 4.44 (br s, 2H), 5.36 (d, J = 15.3 Hz, 1H), 6.47 (dd, J = 8.0, 1.4 Hz, 1H), 6.54 (s, 1H), 7.26 (d, J = 8.0 Hz, 1H), 7.45 (dd, J = 8.5, 1.8 Hz, 1H), 7.80-7.86 (m, 3H) ppm; MS (ISP loop): m/z 519 (M+H).

EXAMPLE 100. (±)-1-(3-Amino-4-cyano-benzyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-carboxylic acid.

- 20 Water (5 drops) is added to a solution containing (±)-1-(3-amino-4-cyano-benzyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-carboxylic acid methyl ester (30 mg, 0.05 mmol), EXAMPLE 99, in a 1:1 mixture of THF/MeOH (2 mL). At ambient temperature, LiOH monohydrate (7 mg, 1.66 mmol) is then added. After 16 h, the reaction mixture is diluted
- 25 with water and purified by reverse-phase HPLC [Buffer A: water w/ 0.1% TFA; Buffer B: CH₃CN w/ 0.1% TFA; Gradient: 0% B to 60% B over 30 min] to provide 10 mg (34%) of the title compound as a white solid. ¹H NMR (300 MHz, d₆-DMSO) δ 3.18 (dd, J = 12.1, 3.5 Hz, 1H), 3.61 (d, J = 16.0 Hz, 1H), 3.77 (d, J = 16.0 Hz, 1H), 3.95 (d, J = 16.0 Hz, 1H), 4.06 (d, J = 12.1 Hz, 1H), 4.14 (m, 1H), 6.40 (d, J = 8.0 Hz, 1H), 6.54 (s, 1H), 7.21 (d, J = 8.0 Hz, 1H), 7.57 (dd, J
- 30 = 8.6, 1.9 Hz, 1H), 8.06 (d, J = 8.6 Hz, 1H), 8.18 (s, 1H), 8.33 (s, 1H) ppm; MS (ISP loop): m/z 505 (M+H).

EXAMPLE 101. 4-[4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-2-oxo-piperazine-1-ylmethyl]benzamidine.

- To a solution of 4-(2-oxopiperazin-1-ylmethyl)benzamidinium bistrifluoroacetate (0.38 g, 0.83mmol), EXAMPLE 66, in CH_2Cl_2 (5 mL) is added Et_3N (0.35 mL, 2.6 mmol) and 6-chloro-benzo[b]thiophene-2-sulfonyl chloride (0.23 g, 0.85 mmol, EXAMPLE 1. After 6 hours, the solution is concentrated. The product is purified by RP-HPLC eluting in a gradient of 10% $\text{CH}_3\text{CN}/\text{H}_2\text{O}$ (0.1% TFA) to 70% $\text{CH}_3\text{CN}/\text{H}_2\text{O}$ (0.1% TFA). The appropriate collected fractions are lyophilized to afford the title compound as a white solid (0.37 g, 0.65 mmol). ^1H NMR (d^6 -DMSO, 300MHz) δ 9.33 (bs, 2H), 8.96 (bs, 2H), 8.30 (s, 1H), 8.18 (s, 1H), 8.04 (d, 1H), 7.70 (m, 2H), 7.50 (m, 1H), 7.28 (m, 2H), 4.55 (s, 2H), 3.86 (s, 2H), 3.44 (m, 2H), 3.22 (m, 2H).

- The following compounds are prepared from 1-(4-Aminoquinazoline-7-ylmethyl)-3-ethyl-piperazine-2-one, Example 77, and the appropriate sulfonyl chloride using the method of Example 101.

| Example | Name | m/z (M+H) |
|---------|--|------------------------|
| 102 | 4-[4-(4-Methoxy-benzenesulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidinium | 403 |
| 103 | 4-[4-(5-Chloro-thieno[3,2-b]pyridine-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidinium | 463, 465 |
| 104 | 4-[4-(6-Chloro-thieno[2,3-b]pyridine-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidinium | 464, 466 Cl pattern |
| 105 | 4-[2-Oxo-4-(thieno[2,3-c]pyridine-2-sulfonyl)-piperazin-1-ylmethyl]-benzamidinium | 430 |
| 106 | 4-[4-(7-Chloro-thieno[2,3-c]pyridine-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidinium | 464, 466 Cl pattern |
| 107 | 4-[4-(5'-Chloro-[2,2']bithiophenyl-5-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidinium | 495, 497 Cl pattern |
| 108 | 4-[4-(4-Chloro-thieno[3,2-c]pyridine-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidinium | 464, 466 Cl pattern |
| 109 | 4-[2-Oxo-4-(toluene-4-sulfonyl)-piperazin-1-ylmethyl]-benzamidinium | 387 |
| 110 | 4-[4-(Benzo[b]thiophene-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidinium | 429 |
| 111 | 4-Amino-3-[4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidinium | 478, 480 Cl pattern |
| 112 | 3-[2-Oxo-4-(toluene-4-sulfonyl)-piperazin-1-ylmethyl]-benzamidinium | 387 |
| 113 | 3-[4-(6-Fluoro-benzo[b]thiophene-2-sulfonyl)-2-oxo-piperazin-1- | 447 |

| | | |
|-----|---|------------------------|
| | ylmethyl]-benzamidine | |
| 114 | 3-[4-(4-Chloro-benzo[b]thiophene-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidine | 463, 465 CI pattern |
| 115 | 3-[4-(5-Chloro-benzo[b]thiophene-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidine | 463, 465 CI pattern |
| 116 | 3-[4-(6-Methoxy-naphthalene-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidine | 453 |
| 117 | 3-[4-[5-(5-Nitro-pyridine-2-sulfonyl)-thiophene-2-sulfonyl]-2-oxo-piperazin-1-ylmethyl]-benzamidine | 565 |
| 118 | 3-[4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidine | 463, 465 CI pattern |
| 119 | 3-[4-[2-(3-Chloro-phenyl)-ethenesulfonyl]-2-oxo-piperazin-1-ylmethyl]-benzamidine | 433, 435 CI pattern |
| 120 | 3-[2-Oxo-4-(4-phenylazo-benzenesulfonyl)-piperazin-1-ylmethyl]-benzamidine | 477 |
| 121 | 3-[4-(Benzo[b]thiophene-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-benzamidine | 429 |

EXAMPLE 122. 4-[4-(6-Chloro-1H-benzoimidazol-2-ylmethyl)-2-oxo-piperazin-1-ylmethyl]-benzamidine.

Hydrogen chloride gas is bubbled into an ice-cooled solution of 4-[4-(6-chloro-1H-benzoimidazol-2-ylmethyl)-2-oxo-piperazin-1-ylmethyl]-benzonitrile (100 mg, 0.264 mmol),
 5 (prepared by deprotecting 4-(4-cyanobenzyl)-3-oxopiperazine-1-carboxylic acid benzyl ester, EXAMPLE 66, Part A, followed by alkylation with 6-chloro-2-chloromethylbenzimidazole) in 15 mL of methanol. The solution contained 3Å molecular sieves. The reaction mixture is stored at -30°C. The methanol is removed on the rotovap. Fresh methanol (20 ml) is added followed by a stream of ammonia gas. The resulting mixture is heated to reflux for three hours. The
 10 reaction mixture is filtered at room temperature. The mother liquor is condensed and the resulting residue is purified by reverse phase HPLC (0-50 % ACN/H₂O). The product is isolated as a white solid with a melting point of 91-95°C.

MS C₂₀H₂₁ClN₆O m/z: 397, 399. Anal. calcd. for C₂₀H₂₁ClN₆O•3C₂HF₃O₂: C, 42.26; H, 3.27; N, 11.37. Found C, 42.20; H, 3.44; N, 11.36.

15 EXAMPLE 123. 4-[4-[3-(5-Chloro-thiophen-2-yl)-(E)-acryloyl]-2-oxopiperazin-1-ylmethyl]benzamidine.

To a solution of 4-(2-oxopiperazin-1-ylmethyl)benzamidinium bistrifluoroacetate (75 mg, 0.16 mmol), EXAMPLE 66, in 1.5 mL of DMF is added N,N-diisopropylethylamine (0.14 mL, 0.80 mmol). After stirring 10 min at room temperature, 3-(5-chloro-thiophen-2-yl)-(E)-acrylic acid (32 mg, 0.17 mmol), EXAMPLE 25, is added, followed by 2-(1H-benzotriazol-1-yl)-1,1,3,3-tetramethyluronium tetrafluoroborate (TBTU) (55 mg, 0.17 mmol). The resulting mixture is stirred at room temperature for 16 h and the solution is concentrated. The crude product is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 70% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to provide the title compound (77 mg, 0.15 mmol) as a white solid.

¹H NMR (d₆-DMSO, 300 MHz) δ 9.27 (bs, 2H), 9.10 (bs, 2H), 7.77 (d, 2H), 7.65 (d, 1H), 7.49 (dd, 2H), 7.39 (m, 1H), 7.15 (d, 1H), 6.89 (d, 1H), 4.65 (s, 2H), 4.45, 4.21 (m, 2H, rotamers), 3.80 (m, 2H), 3.35 (m, 2H). ESI MS, [M+H]⁺=403,405 (CI pattern).

EXAMPLE 124. 3-{4-[3-(5-Chloro-thiophen-2-yl)-(E)-acryloyl]-2-oxopiperazin-1-ylmethyl}benzamidinium.

The title compound is prepared as described in EXAMPLE 123 using 3-(5-chloro-thiophen-2-yl)-(E)-acrylic acid (EXAMPLE 25) and 3-(2-oxopiperazin-1-ylmethyl)benzamidinium bistrifluoroacetate (prepared from 3-bromomethyl toluynitrile as described in EXAMPLE 66). ¹H NMR (DMSO-d₆, 300 MHz) δ 9.32 (bs, 2H), 9.16 (bs, 2H), 7.65 (m, 5H), 7.39 (m, 1H), 7.15 (d, 1H), 6.89 (d, 1H), 4.64 (s, 2H), 4.44, 4.21 (m, 2H, rotamers), 3.93, 3.79 (m, 2H, rotamers), 3.36 (m, 2H). ESI MS, [M+H]⁺=403,405 (CI pattern).

EXAMPLE 125. 3-[4-(6-Chloro-1H-benzimidazol-2-ylmethyl)-2-oxo-piperazin-1-ylmethyl]benzamidinium.

A white solid (13.0 mg, 13%). C₂₀H₂₁ClN₆O MS m/z: 397, 399 Anal. calcd. for C₂₀H₂₁ClN₆O · 3C₂HF₃O₂: C, 42.26; H, 3.27; N, 11.37. Found C, 43.70; H, 3.71; N, 11.95.

EXAMPLE 126. 1-(2-Aminoquinolin-6-ylmethyl)-4-(5'-chloro-[2,2']bithiophenyl-5-sulfonyl)piperazin-2-one.

The title compound is prepared as described in Example 101 using 1-(2-aminoquinolin-6-ylmethyl)piperazin-2-one, EXAMPLE 67, and 5'-chloro-[2,2']bithiophenyl-5-sulfonyl chloride, EXAMPLE 2. The crude product is triturated in CH₂Cl₂ and filtered to provide the title compound as a white solid. ¹H NMR (d₆-DMSO, 300 MHz) δ 7.82 (d, 1H), 7.68 (d, 1H), 7.42 (m, 3H), 7.36 (d, 1H), 7.25 (d, 1H), 7.20 (d, 1H), 6.70 (d, 1H), 6.43 (bs, 2H), 4.53 (s, 2H), 3.78 (s, 2H), 3.31 (m, 4H). MS (ion spray) m/z 519, 521, (M+H), CI pattern.

EXAMPLE 127. 6-[4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-2-oxopiperazin-1-ylmethyl]-1H-quinolin-2-one.

The title compound is prepared as described in EXAMPLE 101, using 6-(2-oxopiperazin-1-ylmethyl)-1H-quinolin-2-one, minor product from EXAMPLE 67, Part D, and 6-chlorobenzo[b]thiophene-2-sulfonyl chloride, EXAMPLE 1. The crude product is triturated in CH_2Cl_2 and filtered to provide the title compound as a white solid. ^1H NMR (d_6 -DMSO, 300 MHz) δ 11.72 (bs, 1H), 8.33 (s, 1H), 8.18 (s, 1H), 8.07 (d, 1H), 7.78 (d, 1H), 7.58 (dd, 1H), 7.45 (s, 1H), 7.30 (dd, 1H), 7.18 (d, 1H), 6.46 (d, 1H), 4.52 (s, 2H), 3.86 (s, 2H), 3.43 (m, 2H), 3.31 (m, 2H). MS (ion spray) m/z 488, 490, (M+H), Cl pattern.

The following compounds are prepared using starting materials prepared as described in Examples 67, 68 and 73 and the appropriate carboxylic acid according to the method of Example 123.

| Example | Name | m/z (M+H) |
|---------|---|------------------------|
| 128 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-thieno[2,3-c]pyridin-3-ylmethyl-piperazin-2-one | 478, 480 Cl pattern |
| 129 | 1-(2-Amino-quinoxalin-6-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | |
| 130 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-thieno[2,3-c]pyridin-2-ylmethyl-piperazin-2-one | 478, 480 Cl pattern |
| 131 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-thieno[3,2-c]pyridin-2-ylmethyl-piperazin-2-one | 478, 480 Cl pattern |
| 132 | 1-(2-Amino-quinolin-6-ylmethyl)-4-(6-chloro-thieno[2,3-b]pyridine-2-sulfonyl)-piperazin-2-one | 488, 490 Cl pattern |
| 133 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-(1-hydroxy-isoquinolin-6-ylmethyl)-piperazin-2-one | 488, 490 Cl pattern |
| 134 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-(1-chloro-isoquinolin-6-ylmethyl)-piperazin-2-one | 506, 508 Cl pattern |
| 135 | 7-[4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-2H-isoquinolin-1-one | 488, 490 Cl pattern |
| 136 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-(1-chloro-isoquinolin-7-ylmethyl)-piperazin-2-one | 506, 508 Cl pattern |
| 137 | 1-(7-Amino-thieno[2,3-c]pyridin-2-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 493, 495 Cl pattern |

| | | |
|-----|--|------------------------|
| 138 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-(2-chloro-quinolin-6-ylmethyl)-piperazin-2-one | 506, 508 CI pattern |
| 139 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-quinolin-6-ylmethyl-piperazin-2-one | 472, 474 CI pattern |
| 140 | 7-[4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-1H-quinolin-2-one | 488, 490 CI pattern |
| 141 | 1-(2-Amino-quinolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 487, 489 CI pattern |
| 142 | 1-(4-Amino-thieno[3,2-c]pyridin-2-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 493, 495 CI pattern |
| 143 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-(1,2,3,4-tetrahydro-isoquinolin-6-ylmethyl)-piperazin-2-one | 475, 477 CI pattern |
| 144 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-isoquinolin-6-ylmethyl-piperazin-2-one | 472, 474 CI pattern |
| 145 | 1-(2-Amino-quinolin-6-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 487, 489 CI pattern |
| 146 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-(decahydro-isoquinolin-6-ylmethyl)-piperazin-2-one | 482, 484 CI pattern |
| 147 | 1-(1-Amino-isoquinolin-6-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 487, 489 CI pattern |
| 148 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-(decahydro-isoquinolin-7-ylmethyl)-piperazin-2-one | 482, 484 CI pattern |
| 149 | 1-(1-Amino-isoquinolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 487, 489 CI pattern |
| 150 | 1-(4-Amino-thieno[3,2-c]pyridin-3-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 493, 495 CI pattern |
| 151 | (+/-)-[1-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-3-oxo-4-thieno[3,2-c]pyridin-2-ylmethyl-piperazin-2-yl]-acetic acid | 536, 538 CI pattern |
| 152 | (+/-)-[1-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-3-oxo-4-thieno[2,3-c]pyridin-2-ylmethyl-piperazin-2-yl]-acetic acid | 536, 538 CI pattern |
| 153 | 1-(1-Amino-isoquinolin-6-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-(E)-acryloyl]-3-(S)-methoxymethyl-piperazin-2-one | 471, 473 CI pattern |
| 154 | 1-(1-Amino-isoquinolin-6-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 475, 477 CI pattern |

| | | |
|-----|--|---|
| 155 | (3S)-1-(7-Chloro-isoquinolin-3-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-methoxymethyl-piperazin-2-one | 494, 496, 498, Cl ₂ pattern |
| 156 | (3S)-1-(7-Chloro-isoquinolin-3-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-(E)-acryloyl]-3-methoxymethyl-piperazin-2-one | 490, 492, 494, Cl ₂ pattern |
| 157 | (S)-4-[3-(5-Chloro-thiophen-2-yl)-acryloyl]-3-ethyl-1-(4-hydroxy-quinolin-7-ylmethyl)-piperazin-2-one | 456, 458 Cl pattern |
| 158 | 1-(2-Amino-quinolin-6-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-(E)-acryloyl]-piperazin-2-one | 427, 429 Cl pattern |

The following compounds are prepared from starting materials prepared as described in Example 67 and the appropriate aryl-methyl bromide or allyl-methyl bromide using a K₂CO₃-mediated alkylation reaction.

| Example | Name | m/z (M+H) |
|---------|--|--|
| 159 | 1-(2-Aminoquinolin-6-ylmethyl)-4-(4-methoxybenzyl)piperazin-2-one | 377 |
| 160 | 1-(2-Aminoquinolin-6-ylmethyl)-4-6-chlorobenzo[b]thiophen-2-ylmethyl)piperazin-2-one | 436, 438 Cl pattern |
| 161 | 1-(2-Aminoquinolin-6-ylmethyl)-4-(5-methoxy-1H-benzoimidazol-2-ylmethyl)piperazin-2-one | 417 |
| 162 | 1-(2-Aminoquinolin-6-ylmethyl)-4-(5'-chloro-[2,2']bithiophenyl-5-ylmethyl)piperazin-2-one | 469, 471 Cl pattern |
| 163 | 1-(2-Aminoquinolin-6-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-piperazin-2-one | 413, 415 Cl pattern |
| 164 | 1-(2-Aminoquinolin-6-ylmethyl)-4-[3-(3,5-dibromo-4-methoxy-phenyl)-[1,2,4]oxadiazol-5-ylmethyl]piperazin-2-one | 601, 603, 605 Br ₂ pattern |
| 165 | 3-[4-(2-Aminoquinolin-6-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-7-fluoro-1H-quinolin-2-one | 431 |
| 166 | 1-(2-Aminoquinolin-6-ylmethyl)-4-(6-chloro-naphthalen-2-ylmethyl)-piperazin-2-one | 430 |

The following compounds are prepared from starting materials prepared as described in Examples 66, 67, 68 and 73 and the appropriate aryl-methyl bromide or allyl-methyl bromide using a K₂CO₃-mediated alkylation reaction.

| Example | Name | m/z (M+H) |
|---------|------|-----------|
|---------|------|-----------|

| | | |
|-----|---|------------------------|
| 167 | 3-(4-Biphenyl-3-ylmethyl-3-oxo-piperazin-1-ylmethyl)-benzamidine | 399 |
| 168 | 4-(5-Chloro-1H-indol-2-ylmethyl)-1-(4-chloro-quinolin-7-ylmethyl)-piperazin-2-one | 439, 441 CI pattern |
| 169 | 1,4-Bis-(5-chloro-1H-indol-2-ylmethyl)-piperazin-2-one | 427 |
| 170 | 1-(4-Amino-thieno[3,2-d]pyrimidin-6-ylmethyl)-4-(7-chloro-isoquinolin-3-ylmethyl)-piperazin-2-one | 439, 441 CI pattern |
| 171 | 1-(4-Amino-thieno[3,2-d]pyrimidin-6-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 444, 446 CI pattern |
| 172 | 1-(4-Amino-thieno[3,2-d]pyrimidin-6-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-piperazin-2-one | 420, 422 CI pattern |
| 173 | 1-(3-Amino-1H-indazol-6-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-piperazin-2-one | 401 |
| 174 | 1-(3-Amino-1H-indazol-6-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 426 |
| 175 | 1-(4-Amino-thieno[2,3-d]pyrimidin-6-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 443 |
| 176 | 4-[4-(6-Chloro-benzo[b]thiophen-2-ylmethyl)-2-oxo-piperazin-1-ylmethyl]-benzamidine | 413, 415 CI pattern |
| 177 | 4-[4-(6-Chloro-benzo[b]thiophen-2-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-benzamidine | 413, 415 CI pattern |
| 178 | 4-(4-Cyclohexylmethyl-2-oxo-piperazin-1-ylmethyl)-benzamidine | 329 |
| 179 | 1-(1-Amino-isoquinolin-6-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 437, 439 CI pattern |
| 180 | 1-(1-Amino-isoquinolin-6-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3-(S)-methoxymethyl-piperazin-2-one | 457, 459 CI pattern |
| 181 | 4-[3-(5-Chloro-thiophen-2-yl)-allyl]-1-[4-(6-methoxy-pyridin-3-yl)-benzyl]-3-(S)-methyl-piperazin-2-one | 468 |
| 182 | 4-[3-(5-Chloro-thiophen-2-yl)-allyl]-3-(S)-methyl-1-[4-(6-oxo-1,6-dihydro-pyridin-3-yl)-benzyl]-piperazin-2-one | 454 |
| 183 | (S)-4-(5-Chloro-1H-indol-2-ylmethyl)-1-(4-chloro-quinolin-7-ylmethyl)-3-methoxymethyl-piperazin-2-one | 483 |
| 184 | (S)-4-(5-Chloro-1H-indol-2-ylmethyl)-1-(4-chloro-quinolin-7-ylmethyl)-3-methyl-piperazin-2-one | 453 |

EXAMPLE 185. 1-(4-Aminoquinazolin-7-ylmethyl)-4-(6-chlorobenzo[b]thiophene-2-sulfonyl)piperazin-2-one.

The title compound is prepared as described in EXAMPLE 101, substituting 1-(4-aminoquinazolin-7-ylmethyl)piperazine-2-one bishydrochloride, EXAMPLE 72, for 4-(2-oxopiperazin-1-ylmethyl)-benzamidine. The product is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 70% CH₃CN/H₂O (0.1% TFA). The appropriate collected fractions are lyophilized to afford the title compound as a white solid. MS (ion spray) m/z 488, 490, (M+H). ¹H NMR (d₆-DMSO, 300 MHz) δ 9.65 (s, 2H), 8.80 (s, 1H), 8.30 (m, 2H), 8.20 (s, 1H), 8.05 (d, 1H), 7.60 (m, 3H), 4.70 (s, 2H), 3.85 (s, 2H), 3.50-3.20 (m, 4H).

EXAMPLE 186. 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-sulfonic acid 3-chloro-benzylamide.

To a solution of 1-(4-aminoquinazolin-7-ylmethyl)piperazine-2-one bishydrochloride, EXAMPLE 72, (0.10g, 0.30mmol) in 9 mL of DMF is added 3-chlorobenzyl sulfamyl catechol (0.09g, 0.30mmol), EXAMPLE 4, Et₃N (0.08g, 0.75 mmol) and DMAP (0.001 g, 0.12 mmol). The solution is heated to 60°C. After 16 h, the solution is concentrated. The crude product is purified by RP-HPLC eluting with a gradient of 10% CH₃CN/H₂O (0.1%TFA) to 100% CH₃CN. The product fractions are lyophilized to give the title compound (0.077g, 0.17 mmol) as the TFA salt. ¹H NMR (d₆-DMSO, 300 MHz) δ 9.82 (bs, 2H), 8.98 (s, 1H), 8.52 (d, 1H), 8.32 (d, 1H), 7.60 (m, 2H), 7.35 (m, 4H), 4.69 (AB, 2H), 4.11 (m, 2H), 3.77 (s, 2H), 3.38 (m, 2H), 3.27 (m, 2H). MS (ion spray) m/z 461, 463, (M+H), Cl pattern.

The following compounds are prepared from the compound of Example 72 and the appropriate sulfonyl chloride using the method of Example 101.

| Example | Name | m/z (M+H) |
|---------|---|------------------------|
| 187 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-thieno[2,3-b]pyridine-2-sulfonyl)-piperazin-2-one | 489, 491 Cl pattern |
| 188 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-chloro-[2,2']bithiophenyl-5-sulfonyl)-piperazin-2-one | 520, 522 Cl pattern |
| 189 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-sulfonic acid 4-chloro-benzylamide | 460 |
| 190 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-isoxazol-3-yl-thiophene-2-sulfonyl)-piperazin-2-one | 471 |
| 191 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(thieno[3,2-b]pyridine-2- | 455 |

| | | |
|-----|---|------------------------|
| | sulfonyl)-piperazin-2-one | |
| 192 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-sulfonic acid [2-(3-chloro-phenyl)-ethyl]-amide | 474 |
| 193 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-sulfonic acid [2-(4-chloro-phenyl)-ethyl]-amide | 474 |
| 194 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-1H-benzimidazole-2-sulfonyl)-piperazin-2-one | 472 |
| 195 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-piperazin-2-one | 464, 466 CI pattern |
| 196 | 4-(3-Amino-benzenesulfonyl)-1-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one | 413 |

The following compounds are prepared from starting materials obtained as described in Examples 75-88 and the appropriate sulfonyl chloride using the method of Example 101.

| Example | Name | m/z (M+H) |
|---------|--|------------------------|
| 197 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-3-(S)-ethyl-piperazin-2-one | 492, 494 CI pattern |
| 198 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-3-(S)-ethyl-piperazin-2-one | 516, 518 CI pattern |
| 199 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-chloro-[2,2']bithiophenyl-5-sulfonyl)-3-(S)-ethyl-piperazin-2-one | 548, 550 CI pattern |
| 200 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-chloro-[2,2']bithiophenyl-5-sulfonyl)-3-(S)-methyl-piperazin-2-one | 534, 536 CI pattern |
| 201 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-3-(S)-methyl-piperazin-2-one | 502, 504 CI pattern |
| 202 | (+/-)-1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-methyl-piperazin-2-one | 502, 504 CI pattern |
| 203 | (+/-)-[4-(4-Amino-quinazolin-7-ylmethyl)-1-(6-chloro-benzo[b]thiophene-2-sulfonyl)-3-oxo-piperazin-2-yl]-acetic acid | 546, 548 CI pattern |

The following compounds are prepared from starting materials obtained as described in Examples 72 and 73 and the appropriate sulfonyl chloride according to the method of Example 101 or the appropriate carboxylic acid according to the method of Example 123.

| Example | Name | m/z (M+H) |
|---------|---|------------------------|
| 204 | 1-(4-Amino-thieno[3,2-d]pyrimidin-6-ylmethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-piperazin-2-one | 470, 472 CI pattern |

| | | |
|-----|---|------------------------|
| 205 | 1-(4-Amino-thieno[3,2-d]pyrimidin-6-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 493, 495 Cl pattern |
| 206 | 1-(4-Amino-thieno[2,3-d]pyrimidin-6-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 494, 496 Cl pattern |
| 207 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-(4-hydroxy-quinazolin-6-ylmethyl)-piperazin-2-one | 489, 491 Cl pattern |
| 208 | 1-(4-Amino-thieno[3,2-d]pyrimidin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 494, 496 Cl pattern |
| 209 | 1-(4-Amino-quinazolin-6-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 488, 490 Cl pattern |
| 210 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-(4-hydroxy-quinazolin-7-ylmethyl)-piperazin-2-one | 489, 491 Cl pattern |
| 211 | 1-(4-Amino-thieno[3,2-d]pyrimidin-6-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-piperazin-2-one | 478, 480 Br pattern |
| 212 | 1-(4-Amino-thieno[3,2-d]pyrimidin-6-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-piperazin-2-one | 434, 436 Cl pattern |

EXAMPLE 213. 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one.

5 A. 2-{4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-2-oxopiperazin-1-ylmethyl}pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester.

To a solution of 2-(2-oxopiperazin-1-ylmethyl)pyrrolo[3,2-c]pyridin-1-carboxylic acid tert-butyl ester (0.71 g, 2.1 mmol), EXAMPLE 69, in CH₃CN (7 mL) is added triethylamine (0.60 mL, 4.3 mmol) followed by 2-(5-chloro-thiophen-2-yl)-ethenesulfonyl chloride, EXAMPLE 3, (0.57 g, 2.1 mmol). The mixture is stirred overnight, then concentrated to dryness. The residue is diluted with CH₂Cl₂ and washed with saturated sodium bicarbonate and brine. The organic layer is dried over MgSO₄, filtered and concentrated in vacuo to give the title compound (1.2 g, 2.1 mmol) as a light yellow solid. The crude material can be used in the subsequent step without further purification. ¹H NMR (CDCl₃, 300 MHz) δ 8.80 (s, 1H), 8.42 (d, 1H), 7.88 (d, 1H), 7.55 (d, 1H), 7.14 (d, 1H), 6.98 (d, 1H), 6.41 (s, 1H), 6.36 (d, 1H), 5.00 (s, 2H), 3.98 (s, 2H), 3.61 (m, 4H), 1.71 (s, 9H). Ion spray MS, [M+H]⁺= 537, 539, Cl pattern.

B. 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one.

Trifluoroacetic acid (2.2 mL, 28.6 mmol) is added dropwise to a slurry of 2-[4-(6-chlorobenzo[b]thiophene-2-sulfonyl)-2-oxopiperazin-1-ylmethyl]pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (1.32 g, 2.4 mmol) in CH₂Cl₂ (25 mL) at 0°C. After 1.5 hours, the ice bath is removed and the solution stirred at room temperature for 4 hours. The reaction mixture is diluted with methylene chloride and washed with saturated sodium bicarbonate and brine. The organic layer is dried over MgSO₄, filtered and concentrated in vacuo to give the title compound as the free base. The crude product is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 100% CH₃CN and the appropriate product fractions are lyophilized to provide the title compound (1.29 g, 2.2 mmol) as a white solid. ¹H NMR (CDCl₃, 300 MHz) δ 14.90 (bs, 1H), 12.81 (s, 2H), 9.12 (s, 1H), 8.41 (d, 1H), 7.89 (d, 1H), 7.60 (d, 1H), 7.50 (d, 1H), 7.20 (d, 1H), 7.12 (d, 1H), 6.95 (s, 1H), 4.80 (s, 2H), 3.98 (s, 2H), 3.48 (s, 4H). Ion spray MS, [M+H]⁺= 437, 439, Cl pattern.

EXAMPLE 214. 4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one.

A. 2-[4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-2-oxopiperazin-1-ylmethyl]pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester.

¹H NMR (CDCl₃, 300 MHz) δ 8.7 (s, 1H), 8.41 (d, 1H), 7.9-7.8 (m, 3H), 7.45 (d, 1H), 7.25 (d, 1H), 6.31 (s, 1H), 4.95 (s, 2H), 3.98 (s, 2H), 3.65 (m, 2H), 3.55 (m, 2H), 1.68 (s, 9H). Ion spray MS, [M+H]⁺= 561, 563, Cl pattern.

B. 4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one trifluoroacetate.

¹H NMR (d₆-DMSO, 300 MHz) δ 14.68 (bs, 1H), 12.6 (s, 1H), 9.1 (s, 1H), 8.36 (d, 1H), 8.29 (d, 1H), 8.17 (s, 1H), 8.05 (d, 1H), 7.82 (d, 1H), 7.56 (m, 2H), 6.83 (s, 1H), 4.1 (s, 2H), 3.84 (s, 2H), 3.38 (m, 4H). Ion spray MS, [M+H]⁺= 461, 463, Cl pattern.

EXAMPLE 215. 4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-1-(5-oxy-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one.

4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one (0.06 g, 0.13 mmol) is dissolved in anhydrous methylene chloride (20 ml), treated with m-chloroperbenzoic acid (0.03 g, mmol) and stirred at room temperature for 4 hours. The solution is diluted with methylene chloride, washed with NaHCO₃, dried (Na₂SO₄) and concentrated. The residue is purified by flash chromatography (5-10 % MeOH/CH₂Cl₂) and converted to the TFA salt to provide the title compound (0.015 g, 0.032 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 9.14 (bs, 1H), 8.95 (d, 1H), 7.8-7.87 (m, 3H), 7.57 (d, 1H), 7.48 (dd, 1H),

6.87 (s, 1H), 4.90 (s, 2H), 3.95 (s, 2H), 3.86 (s, 3H), 3.49 (s, 3H). EI MS, $[M^+]$ = 474, 476, Cl pattern.

EXAMPLE 216. 4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-1-(1-methyl-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one.

4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one (0.59 g, 1.28 mmol), EXAMPLE 214, is dissolved in anhydrous DMF (30 ml), cooled in an ice bath, treated with 60 % sodium hydride (0.061 g, 1.53 mmol) and stirred at room temperature for 30 minutes. The solution is treated with methyl iodide (83 mL, 1.33 mmol) and warmed to room temperature over 4 hours. The reaction is quenched with ammonium chloride solution, diluted with ethyl acetate and separated. The organic layer is washed with brine (3x), dried (Na_2SO_4) and concentrated. The residue is purified by flash chromatography (5-10 % MeOH/ CH_2Cl_2) to provide the title compound (0.31 g, 0.65 mmol). ^1H NMR (CD_3OD , 300 MHz) δ 8.55 (d, 1H), 7.99 (dd, 1H), 7.82 (m, 3H), 7.49 (dd, 1H), 7.43 (d, 1H), 6.55 (s, 1H), 4.75 (s, 2H), 3.96 (s, 2H), 3.52 (m, 4H), 3.86 (s, 3H), 3.49 (s, 3H). Ion Spray MS, $[M+H]^+=477$.

The following compounds are prepared from starting materials obtained as described in Example 69 and the appropriate sulfonyl chlorides according to the method of Example 101.

| Example | Name | m/z (M+H) |
|---------|--|------------------------|
| 217 | 4-(3-Chlorobenzo[b]thiophene-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one | 460 |
| 218 | 4-(6-Chlorothiemo[2,3-b]pyridine-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one. | 462, 464 Cl pattern |
| 219 | 4-(6-Bromobenzo[b]thiophene-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one | 505 |
| 220 | 2-[3-Oxo-4-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazine-1-sulfonyl]-benzo[b]thiophene-6-carbonitrile | 452 |
| 221 | 4-(5'-Chloro-[2,2']bithiophenyl-5-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one | 493 |
| 222 | 4-[2-(4-Chlorophenyl)ethenesulfonyl]-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one | 431 |
| 223 | {2-[4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-2-oxopiperazin-1-ylmethyl]pyrrolo[3,2-c]pyridin-1-yl} acetic acid | 519, 521 Cl pattern |

| | | |
|-----|--|------------------------|
| 224 | 4-(5-Pyridin-4-ylthiophene-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one | 454 |
| 225 | {2-[4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-2-oxopiperazin-1-ylmethyl]pyrrolo[3,2-c]pyridin-1-yl} acetic acid ethyl ester | 547, 549 CI pattern |
| 226 | 4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-1-[1-(2-methoxyethyl)-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl]piperazin-2-one | 519, 520 CI pattern |
| 227 | 4-(6-Chlorothieno[3,2-b]pyridine-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one | 462, 464 CI pattern |
| 228 | {2-[4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-2-oxopiperazin-1-ylmethyl]pyrrolo[2,3-c]pyridin-1-yl} acetic acid methyl ester | 533, 535 CI pattern |
| 229 | 2-[3-Oxo-4-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazine-1-sulfonyl]benzo[b]thiophene-5-carbonitrile | 452 |
| 230 | 4-(5-Aminomethylbenzo[b]thiophene-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)piperazin-2-one | 456 |
| 231 | 2-{2-[4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-2-oxopiperazin-1-ylmethyl]pyrrolo[3,2-c]pyridin-1-yl}acetamide | 518, 520 CI pattern |
| 232 | 4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-1-[1-(2-hydroxyethyl)-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl]piperazin-2-one | 505 |
| 233 | 4-(6-Chloro-1H-benzimidazole-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 445, 447 CI pattern |
| 234 | 4-(1H-Benzimidazole-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 411 |
| 235 | 4-(6-Aminomethyl-benzo[b]thiophene-2-sulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 456 |
| 236 | 1-(1H-Pyrrolo[3,2-c]pyridin-2-ylmethyl)-4-(thieno[2,3-b]pyridine-2-sulfonyl)-piperazin-2-one | 428 |
| 237 | 1-(1H-Pyrrolo[3,2-c]pyridin-2-ylmethyl)-4-(thieno[3,2-b]pyridine-2-sulfonyl)-piperazin-2-one | 428 |
| 238 | 4-[2-(5-Chloro-thiophen-2-yl)-ethanesulfonyl]-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 439, 441 CI pattern |
| 239 | 4-(2-Benzo[b]thiophen-2-yl-ethenesulfonyl)-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 453 |
| 240 | 4-[2-(5-Chloro-4-methoxy-thiophen-2-yl)-ethenesulfonyl]-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 467, 469 |

| | | |
|-----|--|------------------------|
| 241 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-furo[3,2-c]pyridin-2-ylmethyl-piperazin-2-one | 462, 464 |
| 242 | 4-(6-Fluoro-benzo[b]thiophene-2-sulfonyl)-1-furo[3,2-c]pyridin-2-ylmethyl-piperazin-2-one | 446 |
| 243 | 4-(6-Chlorobenzo[b]thiophene-2-sulfonyl)-1-(1H-pyrrolo[2,3-c]pyridin-2-ylmethyl)piperazin-2-one | 460, 462 CI pattern |
| 244 | 4-(6-Chlorothieno[2,3-b]pyridine-2-sulfonyl)-1-(1H-pyrrolo[2,3-c]pyridin-2-ylmethyl)piperazin-2-one | 462, 464 CI pattern |
| 245 | {2-[4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-2-oxo-piperazin-1-ylmethyl]-pyrrolo[2,3-c]pyridin-1-yl}-acetic acid methyl ester | 533, 535 CI pattern |
| 246 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-(1H-pyrrolo[3,2-b]pyridin-2-ylmethyl)-piperazin-2-one | 461, 463 CI pattern |

EXAMPLE 247. 1-(4-Amino-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)piperazin-2-one.

A. (2-Chloro-pyridin-4-yl)-carbamic acid tert-butyl ester.

- 5 NaHMDs (61.7 mL, 1.0M solution in THF) is rapidly added to a solution of 2-chloro-pyridin-ylamine (4.0 g, 30.9 mmol) and BOC anhydride (6.74 g, 30.9 mmol) in THF (28 mL) at RT. The reaction mixture is cooled in an ice water bath (0°C) for 1h then stirred for 3 hr at RT. The gelatinous mixture is concentrated in vacuo and diluted with ethyl acetate and saturated NH₄Cl solution. The organic layer is washed with 0.1N HCl, saturated NaHCO₃ and brine. The
- 10 organic layer is then dried over MgSO₄, filtered and concentrated to dryness. The crude product is chromatographed eluting with 1% MeOH/CH₂Cl₂ to yield the title product (5.57 g, 24.4 mmol) as a yellow solid. ¹H NMR (CDCl₃, 300 MHz) δ 8.18 (d, 1H), 7.48 (d, 1H), 7.12 (dd, 1H), 1.60 (s, 9H). EI MS [M]⁺=228.

15 B. (2-Chloro-3-iodo-pyridin-4-yl)-carbamic acid tert-butyl ester.

- tert-Butyllithium (36.3 mL, 1.7M in pentane) is added dropwise to a solution of (2-chloro-pyridin-4-yl)-carbamic acid tert-butyl ester (6.00 g, 26.2 mmol) in THF (46 mL) at -78 °C under Ar. The yellow/orange mixture is stirred for 2 h at -78°C then warmed to -40 °C for 1 h then cooled to
- 20 -78°C before dropwise addition of I₂ (15.65 g, 61.7 mmol) in THF (49 mL). The reaction mixture is stirred for 1.5 h at -78°C then at -10°C for 30 minutes. The reaction is quenched with saturated NH₄Cl solution then diluted with CH₂Cl₂ and washed with saturated NH₄Cl, saturated sodium thiosulfate, water then brine. The organic layer is dried over MgSO₄, filtered and

concentrated to dryness. The crude product is chromatographed eluting with 1-2% MeOH/CH₂Cl₂ to yield the title product (7.96 g, 22.5 mmol) as a bright yellow solid. ¹H NMR (CDCl₃, 300 MHz) δ 8.14 (d, 1H), 8.02 (d, 1H), 7.32 (bs, 1H), 1.60 (s, 9H). EI MS [M]⁺=354, 356, Cl pattern.

5

C. 4-(4-Chloro-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester.

Trifluoroacetic acid (10 mL) is added to a solution of 2-(4-benzyloxycarbonyl-2-oxo-piperazin-1-ylmethyl)-4-chloro-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (5.66 g, 11.3 mmol, prepared in the same manner as described previously) in CH₂Cl₂ (10 mL). The solution is stirred overnight then diluted with CH₂Cl₂ and washed with saturated NaHCO₃ and brine. The organic layer is dried over MgSO₄, filtered and concentrated to dryness. The crude product is chromatographed eluting with 1-5% MeOH/CH₂Cl₂ to yield the title product (3.81 g, 9.56 mmol) as a foamy yellow solid.

¹H NMR (CDCl₃, 300 MHz) δ 9.43 (bs, 1H), 8.08 (d, 1H), 7.38 (s, 5H), 7.18 (d, 1H), 6.51 (s, 1H), 5.15 (s, 2H), 4.58 (s, 2H), 4.20 (s, 2H), 3.71 (m, 2H), 3.50 (m, 2H). Ion spray [M+H]⁺= 399, 401, Cl pattern.

10

15

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D. 4-(1-Benzenesulfonyl-4-chloro-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester.

Powdered NaOH (0.96 g, 23.9 mmol) followed by nBu₄NHSO₄ (0.32 g, 0.96 mmol) and benzene sulfonyl chloride (1.8 mL, 14.1 mmol) is added to a solution of 4-(4-chloro-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester (3.81 g, 9.56 mmol) in CH₂Cl₂ (32 mL) at RT. The resulting slurry is stirred for 3.5 h then diluted with CH₂Cl₂ and washed with saturated NaHCO₃ and brine. The organic layer is dried over MgSO₄, filtered and concentrated to dryness. The crude product is chromatographed eluting with 1-5% MeOH/CH₂Cl₂ to yield the title product (5.06 g, 9.38 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 8.23 (d, 1H), 7.97 (d, 1H), 7.84 (d, 2H), 7.61 (d, 1H), 7.51 (m, 2H), 7.38 (s, 5H), 6.50 (s, 1H), 5.18 (s, 2H), 5.03 (s, 2H), 4.29 (s, 2H), 4.29 (s, 2H), 3.80 (m, 2H), 3.51 (m, 2H). Ion spray [M+H]⁺= 539, 541, Cl pattern.

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E. 1-(1-Benzenesulfonyl-4-chloro-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

TMSI (2.7 mL, 19.0 mmol) is added to a solution of 4-(1-benzenesulfonyl-4-chloro-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-3-oxo-piperazine-1-carboxylic acid benzyl ester (5.06 g, 9.38 mmol) in CH₃CN (134 mL) at 0°C. The reaction mixture is warmed to RT and stirred for 5

35

hours. The reaction mixture is concentrated to dryness and the red residue is diluted with MeOH and concentrated to dryness (this is repeated twice). The mixture is diluted with CH₂Cl₂ and washed with saturated NaHCO₃ and brine. The organic layer is dried over MgSO₄, filtered and concentrated to dryness. The crude product is chromatographed eluting with 1-5%

- 5 MeOH/CH₂Cl₂ to yield the title product (0.70 g, 1.74 mmol) and unreacted starting material (3.58 g, 6.64 mmol). ¹H NMR (CDCl₃, 300 MHz) δ 8.20 (d, 1H), 7.93 (d, 1H), 7.85 (d, 2H), 7.60 (d, 1H), 7.51 (m, 2H), 6.50 (s, 1H), 5.01 (s, 2H), 3.45 (m, 2H), 3.18 (m, 2H). Ion spray [M+H]⁺= 405, 407, Cl pattern.

10 F. 1-(4-Amino-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-4-(6-chlorobenzo[b]thiophene-2-sulfonyl)piperazin-2-one.

- Anhydrous ammonium acetate (0.56 g, 7.2 mmol), phenol (0.45 g, 4.8 mmol) and 1-(1-benzenesulfonyl-4-chloro-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one (0.31 g, 0.48 mmol, prepared as described previously) are heated to
15 100°C for 3.5 days. The mixture is cooled to RT then the crude product is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 100% CH₃CN then the appropriate product fractions are lyophilized to provide the title compound (1.29 g, 2.2 mmol) as a white solid (22.4 mg, 0.038 mmol). ¹H NMR (DMSO-d₆, 300 MHz) δ 12.40 (bs, 1H), 12.00 (bs, 1H), 8.31 (d, 1H), 8.20 (s, 1H), 8.06 (d, 1H), 8.02 (bs, 2H), 7.57 (dd, 1H), 7.48 (m, 1H), 6.89 (d, 1H),
20 6.81 (s, 1H), 4.60 (s, 2H), 3.81 (s, 2H), 3.40 (m, 4H). LR-FAB MS, [M+H]⁺=476, 478.

EXAMPLE 248. 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-5-(±)-hydroxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

- 25 A. 2-[4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-2-(±)-hydroxymethyl-6-oxo-piperazin-1-ylmethyl]-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester.

- Sodium borohydride (0.005 g, 0.13 mmol) is added to a solution of 2-[4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-2-(±)-methoxycarbonyl-6-oxo-piperazin-1-ylmethyl]-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (0.04 g, 0.07 mmol), (prepared from 2-(2-(±)-methoxycarbonyl-6-oxo-piperazin-1-ylmethyl)-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester, EXAMPLE 71, and 2-(5-chloro-thiophen-2-yl)-ethenesulfonyl chloride, EXAMPLE 3, using the procedure described in EXAMPLE 214, Part A) in MeOH (3 mL) at RT. The reaction mixture is stirred for 6 h then quenched with water and concentrated in vacuo. The crude product (0.04 g) is taken onto the next step without further purification.

B. 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-5-(±)-hydroxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

Trifluoroacetic acid (1.8 mL) is added to a solution of 2-{4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-2-(±)-hydroxymethyl-6-oxo-piperazin-1-ylmethyl}-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (0.04 g) in CH₂Cl₂ (4.2 mL) at RT. The reaction mixture is stirred for 4 h then concentrated in vacuo. The title compound is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 100% CH₃CN and lyophilizing the appropriate product fractions. ¹H NMR (DMSO-d₆, 300 MHz) δ 9.10 (s, 1H), 8.46 (d, 1H), 7.82 (d, 1H), 7.50 (d, 1H), 7.43 (d, 1H), 7.14 (d, 1H), 7.01 (d, 1H), 6.94 (s, 1H), 5.12 (bs, 1H), 4.80 (AB, 2H), 3.98 (d, 2H), 3.90 (m, 1H), 3.40-3.50 (m, 4H). APCI MS, [M+H]⁺=467, 469.

The following compounds are prepared from starting materials obtained using the methods of Examples 69, 70 and 71 and the appropriate sulfonyl chlorides according to the method of Example 101.

| Example | Name | m/z |
|---------|---|---------------------------|
| 249 | 1-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-5-oxo-4-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazine-2-(±)-carboxylic acid methyl ester | 519, 521 Cl pattern |
| 250 | 1-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-5-oxo-4-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazine-2-(±)-carboxylic acid methyl ester | 495, 497 Cl pattern |
| 251 | 1-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-5-oxo-4-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazine-2-(±)-carboxylic acid | 505, 507 Cl pattern |
| 252 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-5-(±)-hydroxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 491, 493 Cl pattern |

The following enantiomerically pure compounds are obtained by chiral resolution on a CHIRACEL OD prep column.

| Example | Name | %ee | m/z |
|---------|---|------------|---------------------------|
| 253 | 1-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-5-oxo-4-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazine-2-(-)-carboxylic acid methyl ester | 99% (-) | 495, 497 Cl pattern |

| | | | |
|-----|---|------------|---------------------------|
| 254 | 1-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-5-oxo-4-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazine-2-(+)-carboxylic acid methyl ester | 95% (+) | 495, 497 Cl pattern |
|-----|---|------------|---------------------------|

EXAMPLE 255. 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-6-(R)-hydroxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

A. 6-(R)-(tert-Butyl-dimethyl-silanyloxymethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

Trifluoroacetic acid (0.25 mL) is added to a solution of 2-{2-(R)-(tert-butyl-dimethyl-silanyloxymethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-6-oxo-piperazin-1-ylmethyl}-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (0.025 g, 0.037 mmol) in CH₂Cl₂ (0.5 mL) at room temperature. The reaction mixture is stirred for 2 h then concentrated to dryness. The residue is diluted with CH₂Cl₂ and washed with saturated NaHCO₃ and brine. The organic layer is dried over MgSO₄, filtered and concentrated in vacuo. The crude product (0.019 g, 0.033 mmol) is used in the subsequent step without further purification.

B. 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-6-(R)-hydroxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

Glacial acetic acid (3 mL, 0.046 mmol) and tetrabutylammonium fluoride (92 mL, 0.092 mmol) is added to a solution of 6-(R)-(tert-butyl-dimethyl-silanyloxymethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one (0.019 g, 0.033 mmol) in THF (0.5 mL). The resulting solution is stirred for 4 h then concentrated in vacuo. The crude product is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 100% CH₃CN and the appropriate product fractions are lyophilized to provide the title compound (0.009 g, 0.016 mmol) as a white solid. ¹H NMR (DMSO-d₆, 300 MHz) δ 14.50 (bs, 1H), 12.60 (bs, 1H), 9.18 (s, 1H), 8.38 (d, 1H), 7.89 (d, 1H), 7.61 (d, 1H), 7.50 (d, 1H), 7.21 (d, 1H), 7.08 (d, 1H), 6.90 (s, 1H), 5.03 (s, 2H), 4.63 (d, 2H), 3.70-3.90 (AB, 2H), 3.75 (m, 1H), 3.21 (m, 2H). Ion spray MS, [M+H]⁺=467, 469, Cl pattern.

The following compounds are prepared from starting materials obtained as described in Examples 69, 70 and 71 and the appropriate sulfonyl chloride according to the method of Example 101.

| Example | Name | m/z |
|---------|--|----------|
| 256 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-6-(R)-hydroxymethyl-1-(1H- | 491, 493 |

| | | |
|-----|---|---------------------------|
| | pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | |
| 257 | 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-6-oxo-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazine-2-(±)-carboxylic acid methyl ester | 495, 497 Cl pattern |
| 258 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazine-2-(±)-carboxylic acid methyl ester | 519, 521 Cl pattern |
| 259 | 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-6-oxo-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazine-2-(±)-carboxylic acid | 481, 483 Cl pattern |
| 260 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazine-2-(±)-carboxylic acid | 505, 507 Cl pattern |
| 261 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-6-(±)-hydroxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 491, 493 Cl pattern |
| 262 | 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-6-(±)-hydroxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 467, 469 Cl pattern |
| 263 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazine-2-(±)-carboxylic acid amide | 504, 506 Cl pattern |
| 264 | 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-3-(S)-methoxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 481, 483 |
| 265 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-3-(S)-methoxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 505, 507 |
| 266 | 4-(5'-Chloro-[2,2']bithiophenyl-5-sulfonyl)-3-(S)-methoxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 537, 539 |
| 267 | 4-[2-(4-Chloro-phenyl)-ethenesulfonyl]-3-(S)-methoxymethyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 475, 477 |

EXAMPLE 268. 1-(4-Aminoquinazolin-7-ylmethyl)-4-(6-chlorobenzo[b]thiophene-2-ylmethyl)piperazin-2-one.

To a solution of 1-(4-aminoquinazoline-7-ylmethyl)piperazine-2-one bishydrochloride (1.84 g, 5.73 mmol), EXAMPLE 72, in DMF (20 mL) is added 2-bromomethyl-6-chloro-benzo[b]thiophene, EXAMPLE 5, (1.5 g, 5.73 mmol) and K₂CO₃ (4.0 g, 28.7 mmol). The

solution is stirred for 16 hours. After this time, the solution is diluted with water. The solution is acidified with trifluoroacetic acid. The product is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 50% CH₃CN/H₂O (0.1% TFA). The appropriate collected fractions are lyophilized to afford the title compound as a white solid. ¹H NMR (d⁶-DMSO, 300MHz) δ 9.78 (bs, 3H), 8.82 (s, 1H), 8.34 (d, 1H), 8.07 (s, 1H), 7.81 (d, 1H), 7.63 (d, 1H), 7.51 (s, 1H), 7.32 (m, 2H), 4.71 (s, 2H), 3.95 (s, 2H), 3.28 (m, 4H), 2.80 (m, 2H).

EXAMPLE 269. 1-(4-Aminoquinazolin-7-ylmethyl)-4-(6-chloro-1H-benzoimidazol-2-ylmethyl)piperazin-2-one.

A mixture of 1-(4-aminoquinazolin-7-ylmethyl)piperazin-2-one (50 mg, 0.15 mmol), EXAMPLE 72, 6-chloro-2-chloromethylbenzimidazole (30.5 mg, 0.15 mmol) and potassium carbonate (83 mg, 0.6 mmol) in 2 mL of DMF is stirred at ambient temperature overnight. The mixture is purified on reverse phase HPLC (CH₃CN/H₂O/TFA) to give the trifluoroacetic acid salt of 1-(4-aminoquinazolin-7-ylmethyl)-4-(6-chloro-1H-benzoimidazol-2-ylmethyl)piperazin-2-one (25 mg) as a solid. ¹H NMR (CD₃OD, 300 MHz) δ 8.69 (s, 1H), 8.33 (d, 1H), 7.79 (s, 1H), 7.75-7.69 (m, 3H), 7.57-7.54 (m, 1H), 4.86 (s, 2H), 4.22 (s, 2H), 3.31 (m, 4H), 2.99 (m, 2H). MS m/z 422 (M+H).

EXAMPLE 270. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzothiazol-2-ylmethyl)-piperazin-2-one.

To a solution of 1-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one (76 mg, 0.23 mmol), EXAMPLE 72, in 2 mL of DMF is added potassium carbonate (127 mg, 0.92 mmol) followed by 6-chloro-2-chloromethyl-benzothiazole (prepared according to the procedure of B.L.Mylari, Synthesis Comm. 1989, 16, 2921) (50 mg, 0.23 mmol). The resulting mixture is stirred overnight at room temperature. The undissolved potassium carbonate is removed by filtration and the mother liquor is purified by reverse phase HPLC (10-100% CH₃CN/H₂O). The desired product is obtained as a white solid with a melting point of 123-126°C. C₂₁H₁₉ClN₆OS MS m/z: 439, 441. Anal. calcd. for C₂₁H₁₉ClN₆OS · 2C₂H₅HF₃O₂: C, 45.02; H, 3.17; N, 12.60. Found C, 44.15; H, 3.19; N, 11.79.

EXAMPLE 271. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzooxazol-2-ylmethyl)-piperazin-2-one.

The desired product (10.0 mg, 7 %) is isolated as a white solid. C₂₁H₁₉ClN₆O₂ MS m/z: 423, 425.

EXAMPLE 272. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-benzothiazol-2-ylmethyl)-piperazin-2-one.

The desired product (19.0 mg, 22%) is obtained as a white solid. $C_{21}H_{19}ClN_6OS$ MS m/z: 438,440. Anal. calcd. for $C_{21}H_{19}ClN_6OS \cdot 2C_2HF_3O_2$: C, 45.02; H, 3.17; N, 12.60. Found C, 43.35; H, 3.26; N, 12.65.

EXAMPLE 273. 3-[4-(4-Aminoquinazoline-7-ylmethyl)-3-oxopiperazin-1-ylmethyl]-7-chloro-1H-quinolin-2-one.

The title compound is prepared as described in EXAMPLE 268, substituting 3-bromomethyl-7-chloro-1H-quinoline-2-one, EXAMPLE 8, for 2-bromomethyl-6-chlorobenzo[b]thiophene. The product is purified by RP-HPLC eluting in a gradient of 10% CH_3CN/H_2O (0.1% TFA) to 50% CH_3CN/H_2O (0.1% TFA). The appropriate collected fractions are lyophilized to afford the title compound as a white solid.

1H NMR (d_6 -DMSO, 300MHz) δ 12.18 (bs, 1H), 9.75 (m, 1H), 8.86 (s, 1H), 8.40 (m, 1H), 8.11 (d, 1H), 8.10 (s, 1H), 7.78 (m, 1H), 7.69 (m, 2H), 7.37 (m, 1H), 4.80 (s, 2H), 4.10 (m, 2H), 3.47 (m, 4H), 3.30 (m, 2H). MS (ion spray) m/z 449, (M+H).

EXAMPLE 274. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-chloro-1H-indol-6-ylmethyl)-piperazin-2-one.

A. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-chloro-1-(toluene-4-sulfonyl)-1H-indol-6-ylmethyl)-piperazin-2-one.

The title compound is prepared as described in EXAMPLE 268 using 6-bromomethyl-3-chloro-1-(toluene-4-sulfonyl)-1H-indole, EXAMPLE 16, in place of 2-bromomethyl-6-chlorobenzo[b]thiophene. The crude material is purified by RP-HPLC eluting in a gradient of 10% CH_3CN/H_2O (0.1% TFA) to 80% CH_3CN/H_2O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to give a white solid. 1H NMR ($DMSO-d_6$, 300 MHz) δ 9.75 (bs, 2H), 8.82 (s, 1H), 8.40 (d, 1H), 7.64 (m, 2H), 7.60 (m, 2H), 7.40 (d, 1H), 7.23 (m, 1H), 7.19 (m, 2H), 6.99 (d, 2H), 5.09 (s, 2H), 4.78 (s, 2H), 4.10 (m, 2H), 3.40 (m, 4H), 2.49 (s, 3H).

B. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-chloro-1H-indol-6-ylmethyl)-piperazin-2-one.

To a solution of 1-(4-amino-quinazolin-7-ylmethyl)-4-(3-chloro-1-(toluene-4-sulfonyl)-1H-indol-6-ylmethyl)-piperazin-2-one ditrifluoroacetate (31 mg, 0.04 mmol) in 2 mL of MeOH is added 0.3 mL of 1N NaOH solution. The solution is heated at 100°C for 3 hours. After this time, the solution is diluted with water/acetonitrile and neutralized with trifluoroacetic acid. The

crude material is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 60% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to give the title compound (21 mg, 0.03 mmol) as a white solid. ¹H NMR (DMSO-d₆, 300 MHz) δ 9.71 (bs, 2H), 8.81 (s, 1H), 8.40 (d, 1H), 7.63 (m, 3H), 7.53 (d, 1H), 7.50 (s, 1H), 7.20 (d, 1H), 4.78 (s, 2H), 4.30-3.10 (m, 8H). ESI MS, [M+H]⁺=421, 423 (CI pattern).

EXAMPLE 275. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-(E)-allyl]-piperazin-2-one.

To a solution of 1-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one bishydrochloride (100 mg, 0.31 mmol), EXAMPLE 72, in 3 mL of DMF is added 2-(3-bromo-(E)-propenyl)-5-chloro-thiophene (73 mg, 0.31 mmol), prepared as described in EXAMPLE 17., and K₂CO₃ (0.21 g, 1.54 mmol). The solution is stirred at room temperature for 16 hours. After this time, the solution is diluted with water/acetonitrile and neutralized with trifluoroacetic acid. The crude material is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 60% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to give the title compound (80 mg, 0.12 mmol) as a white solid. ¹H NMR (DMSO-d₆, 300 MHz) δ 9.76 (bs, 2H), 8.81 (s, 1H), 8.40 (d, 1H), 7.70 (s, 1H), 7.62 (dd, 1H), 7.10 (m, 2H), 6.90 (d, 1H), 6.05 (dt, 1H), 4.80 (s, 2H), 3.77 (m, 4H), 3.50 (m, 2H), 3.37 (m, 2H). ESI MS, [M+H]⁺=414, 416 (CI pattern). Anal. (C₂₀H₂₀ClN₅OS·2.0TFA·1.1H₂O) C, H, N.

EXAMPLE 276. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-but-2-(E)-enyl]-piperazin-2-one ditrifluoroacetate.

¹H NMR (DMSO-d₆, 300 MHz) δ 9.70 (bs, 2H), 8.82 (s, 1H), 8.40 (d, 1H), 7.68 (s, 1H), 7.61 (d, 1H), 7.10 (m, 2H), 5.88 (t, 1H), 4.79 (s, 2H), 3.75 (m, 4H), 3.49 (m, 2H), 3.29 (m, 2H), 2.09 (s, 3H). EI MS, [M+H]⁺=427, 429 (CI pattern).

EXAMPLE 277. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-2-methyl-(E)-allyl]-piperazin-2-one ditrifluoroacetate.

¹H NMR (DMSO-d₆, 300 MHz) δ 9.80 (bs, 2H), 8.85 (s, 1H), 8.41 (d, 1H), 7.70 (s, 1H), 7.68 (d, 1H), 7.06 (d, 1H), 7.05 (d, 1H), 6.70 (bs, 1H), 4.80 (s, 2H), 4.30 (bs, 2H), 3.45 (m, 4H), 3.10 (m, 2H), 1.99 (s, 3H). ESI MS, [M+H]⁺=428, 430 (CI pattern).

EXAMPLE 278. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-furan-2-yl)-(E)-allyl]-piperazin-2-one.

To a solution of 1-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one (50 mg, 0.20 mmol), EXAMPLE 72, in 3 mL of acetonitrile is added 3-(4-bromo-furan-2-yl)-(E)-propenal (43 mg, 0.22 mmol), prepared as described in EXAMPLE 18, 2 drops of HOAc and sodium triacetoxyborohydride (62 mg, 0.29 mmol). The solution is stirred at room temperature for 16 hours. After this time, the solution is diluted with water/acetonitrile. The crude material is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 80% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to give the title compound (48 mg, 0.07 mmol) as a white solid. ¹H NMR (DMSO-d₆, 300 MHz) δ 9.75 (bs, 2H), 8.85 (s, 1H), 8.60 (d, 1H), 7.95 (s, 1H), 7.69 (s, 1H), 7.62 (d, 1H), 6.80 (s, 1H), 6.65 (d, 1H), 6.19 (dt, 1H), 4.80 (s, 2H), 3.70 (m, 4H), 3.50 (m, 2H), 3.28 (m, 2H). ESI MS, [M+H]⁺=441,443 (Br pattern).

EXAMPLE 279. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(6-methoxy-pyridin-3-yl)-(E)-allyl]-piperazin-2-one.

Nitrogen (g) is bubbled through a solution of 1-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one (100 mg, 0.39 mmol), EXAMPLE 72, in 2 mL of CH₃CN. After 5 min, acetic acid 3-(6-methoxy-pyridin-3-yl)-(E)-allyl ester (75 mg, 0.36 mmol, prepared as described in EXAMPLE 19 in 2 mL of CH₃CN, palladium(II) acetate (catalytic amount), triphenylphosphine (catalytic amount), 2 mL of H₂O and 0.5 mL of triethylamine are added to the solution. The mixture is heated at 80°C for 1 hours. At this time, the mixture is cooled, filtered and concentrated in vacuo. The crude material is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 60% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to give the title compound (44 mg, 0.07 mmol) as a white solid. ¹H NMR (DMSO-d₆, 300 MHz) δ 9.86 (s, 1H), 9.79 (s, 1H), 8.83 (s, 1H), 8.40 (d, 1H), 8.25 (s, 1H), 7.95 (d, 1H), 7.75 (s, 1H), 7.63 (d, 1H), 6.86 (d, 1H), 6.82 (d, 1H), 6.32 (dt, 1H), 4.78 (s, 2H), 3.98 (s, 2H), 3.93 (m, 2H), 3.85 (s, 3H), 3.53 (m, 4H). ESI MS, [M+H]⁺=405.

EXAMPLE 280. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-(E)-allyl]-4-oxy-piperazin-2-one.

To a solution of 1-(4-amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-(E)-allyl]-piperazin-2-one ditrifluoroacetate (0.60 g, 0.94 mmol), prepared as described in EXAMPLE 275, in 25 mL of CH₂Cl₂ is added m-chloroperoxybenzoic acid (0.30 g, 0.96 mmol, 55% pure grade). The mixture is stirred at room temperature for 3 h and then concentrated in vacuo. The crude material is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 60% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are

combined and lyophilized to give the title compound (0.5 mg, 0.76 mmol) as a white solid. ¹H NMR (DMSO-d₆, 300 MHz) δ 9.68 (bs, 2H), 8.79 (s, 1H), 8.39 (d, 1H), 7.68 (s, 1H), 7.60 (d, 1H), 7.17 (d, 1H), 7.12 (d, 1H), 7.06 (d, 1H), 6.17 (dt, 1H), 4.84 (s, 2H), 4.53 (m, 2H), 4.50 (AB, 2H), 4.04 (m, 2H), 3.78 (m, 1H), 3.60 (m, 1H). ESI MS, [M+H]⁺=430,432 (CI pattern).

5 Anal. (C₂₀H₂₀ClN₅O₂S·2.0TFA·1.4H₂O) C, H, N.

EXAMPLE 281. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-prop-2-ynyl]-piperazin-2-one.

The title compound is prepared as described in EXAMPLE 275 using 2-(3-bromo-prop-1-ynyl)-5-chloro-thiophene (prepared as described in EXAMPLE 20) in place of 2-(3-bromo-(E)-propenyl)-5-chloro-thiophene. The crude material is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 70% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to give the title compound as a white solid. ¹H NMR (DMSO-d₆, 300 MHz) δ 9.77 (bs, 2H), 8.83 (s, 1H), 8.38 (d, 1H), 7.63 (d, 1H), 7.58 (s, 1H), 7.25 (d, 1H), 7.13 (d, 1H), 4.74 (s, 2H), 3.74 (s, 2H), 3.32 (m, 4H), 2.85 (m, 2H). ESI MS, [M+H]⁺=412, 414 (CI pattern).

EXAMPLE 282. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-propyl]-piperazin-2-one

20 The title compound is prepared as described in EXAMPLE 278 using 3-(5-chloro-thiophen-2-yl)-propionaldehyde (EXAMPLE 28, Part A) in place of 3-(4-bromo-furan-2-yl)-(E)-propenal. The crude material is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 60% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to give the title compound as a white solid. ¹H NMR (DMSO-d₆, 300 MHz) δ 9.77 (bs, 2H), 8.81 (s, 1H), 8.39 (d, 1H), 7.71 (s, 1H), 7.60 (d, 1H), 6.95 (d, 1H), 6.77 (d, 1H), 4.78 (s, 2H), 3.88 (m, 2H), 3.50 (m, 2H), 3.42 (m, 2H), 3.05 (m, 2H), 2.80 (t, 2H), 1.96 (m, 2H). ESI MS, [M+H]⁺=416,418 (CI pattern).

EXAMPLE 283. 1-(4-Amino-quinazolin-7-ylmethyl)-4-prop-2-ynyl-piperazin-2-one.

30 A. 1-(4-Amino-quinazolin-7-ylmethyl)-4-prop-2-ynyl-piperazin-2-one.

Propargyl bromide (0.29 g, 1.95 mmol) is added to a solution containing 1-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one (0.5 g, 1.95 mmol), EXAMPLE 72, and K₂CO₃ (0.40 g, 2.93 mmol) in DMSO (10 mL) at ambient temperature. After 15 min, the reaction mixture is partitioned between aqueous NaHCO₃ (100 mL) and CH₂Cl₂ (100 mL) and the layers are separated. The aqueous phase is subsequently saturated with NaCl and extracted three times

with CHCl_3 (50 mL). The combined organic phase is washed with brine, dried over anhydrous Na_2SO_4 , filtered and concentrated. The residue is purified by flash silica gel chromatography (CH_2Cl_2 to 10% $\text{MeOH}/\text{CH}_2\text{Cl}_2$) to provide 390 mg (68%) of the title compound as a white solid. ^1H NMR (300 MHz, CDCl_3) δ 2.68 (m, 1H), 3.13-3.37 (m, 6H), 4.07 (app q, $J = 5.2$ Hz, 1H), 4.63 (s, 2H), 7.28 (dd, $J = 8.4, 1.4$ Hz, 1H), 7.42 (s, 1H), 7.72 (br s, 2H), 8.14 (d, $J = 8.4$ Hz, 1H), 8.34 (s, 1H) ppm; MS (ISP loop): m/z 296 (M+H).

EXAMPLE 284. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-biphenyl-2-yl-prop-2-ynyl)-piperazin-2-one.

A solution containing 1-(4-amino-quinazolin-7-ylmethyl)-4-prop-2-ynyl-piperazin-2-one (50 mg, 0.17 mmol), EXAMPLE 283, 2-bromobiphenyl (44 mg, 0.19 mmol), Et_3N (69 mg, 0.68 mmol), $(\text{Ph}_3\text{P})_4\text{PdCl}_2$ (6 mg, 0.008 mmol), and CuI (1 mg, 0.005 mmol) in anhydrous DMF (2 mL) is warmed at 80°C for 1 hours. The reaction mixture is cooled to 50°C and the solvent is removed over 16 h under a stream of nitrogen. The crude residue is purified by flash silica gel chromatography (CH_2Cl_2 to 10% $\text{MeOH}/\text{CH}_2\text{Cl}_2$) to afford a colorless gum which is triturated with ethyl alcohol to provide 4 mg (5%) of the title compound as a white solid. ^1H NMR (300 MHz, d_6 -DMSO) δ 3.03 (s, 2H), 3.14 (m, 2H), 3.31 (m, 2H), 3.50 (s, 2H), 7.21-7.55 (m, 11H), 7.76 (br s, 2H), 8.18 (d, $J = 8.6$ Hz, 1H), 8.36 (s, 1H) ppm; MS (ion spray): m/z 448 (M+H).

EXAMPLE 285. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

A. (3-{3-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-yl]-prop-1-ynyl}-pyridin-4-yl)-carbamic acid tert-butyl ester.

A solution containing 1-(4-amino-quinazolin-7-ylmethyl)-4-prop-2-ynyl-piperazin-2-one (100 mg, 0.34 mmol), EXAMPLE 283, (3-iodo-pyridin-4-yl)-carbamic acid tert-butyl ester, EXAMPLE 69, Part B, (108 mg, 0.34 mmol), Et_3N (140 mg, 1.36 mmol), $(\text{Ph}_3\text{P})_4\text{PdCl}_2$ (12 mg, 0.017 mmol), and CuI (2 mg, 0.01 mmol) in anhydrous DMF (5 mL) is stirred at ambient temperature. After 5 h, the reaction mixture is diluted with EtOAc (50 mL) and water (50 mL) and the layers are separated. The aqueous layer is extracted twice with EtOAc (25 mL) and the combined organic phase is washed with brine, dried over anhydrous Na_2SO_4 , filtered and concentrated. The crude residue is purified by flash silica gel chromatography (CH_2Cl_2 to 10% $\text{MeOH}/\text{CH}_2\text{Cl}_2$) to provide 59 mg (36%) of the title compound as a colorless oil. ^1H NMR (300 MHz, CDCl_3) δ 1.49 (s, 9H), 2.84 (m, 2H), 3.35 (m, 2H), 3.44 (s, 2H), 3.71 (s, 2H), 4.75 (s, 2H), 6.19 (br s, 2H), 7.24 (d, $J = 5.5$ Hz, 1H), 7.41 (d, $J = 8.4$ Hz, 1H), 7.66 (s, 1H), 7.79 (d, $J = 8.4$

Hz, 1H), 8.05 (d, J = 5.5 Hz, 1H), 8.37 (s, 1H), 8.49 (s, 1H), 8.58 (s, 1H) ppm; MS (ISP loop): m/z 488 (M+H).

B. 2-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester.

1,8-Diazabicyclo[5.4.0]undec-7-ene (37 mg, 0.24 mmol) is added to a suspension containing (3-{3-[4-(4-amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-yl]-prop-1-ynyl}-pyridin-4-yl)-carbamic acid tert-butyl ester (59 mg, 0.12 mmol) in anhydrous CH₃CN (5 mL) and the mixture is warmed to 50 °C. Dimethylformamide (1 mL) is added to solubilize and the homogeneous solution is maintained for 5 h at 50°C. The reaction mixture is diluted with EtOAc (50 mL) and water (50 mL) and the layers are separated. The aqueous layer is extracted twice with EtOAc (25 mL) and the combined organic phase is washed with brine, dried over anhydrous Na₂SO₄, filtered and concentrated to provide 50 mg of the product as a crude solid which is used directly without further purification. ¹H NMR (300 MHz, CDCl₃) δ 1.64 (s, 9H), 2.78 (m, 2H), 3.30 (m, 2H), 3.37 (s, 2H), 3.95 (s, 2H), 4.74 (s, 2H), 6.24 (br s, 2H), 6.63 (s, 1H), 7.40 (dd, J = 8.5, 1.6 Hz, 1H), 7.64 (s, 1H), 7.81 (d, J = 5.8 Hz, 1H), 7.83 (d, J = 8.5 Hz, 1H), 7.99 (s, 1H), 8.39 (d, J = 5.8 Hz, 1H), 8.58 (s, 1H), 8.77 (s, 1H) ppm.

C. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

To a solution containing 2-[4-(4-amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (50 mg, 0.12 mmol) in CH₂Cl₂ (5 mL) is added TFA (1 mL) at ambient temperature. After 16 h, the reaction mixture is concentrated to dryness, diluted with water and purified by reverse-phase HPLC [Buffer A: water w/ 0.1% TFA; Buffer B: CH₃CN w/ 0.1% TFA; Gradient: 0% B to 45% B over 30 min] to provide 34 mg (73%, two steps) of the title compound as a white, lyophilized solid. ¹H NMR (300 MHz, CDCl₃) δ 2.77 (s, 3H), 3.23 (s, 2H), 3.31 (m, 2H), 3.89 (s, 2H), 4.00 (br s, 3H), 4.71 (s, 2H), 6.94 (s, 1H), 7.60 (m, 2H), 7.84 (d, J = 6.5 Hz, 1H), 8.36 (m, 2H), 8.81 (s, 1H), 9.18 (s, 1H), 9.73 (br s, 2H), 12.87 (s, 1H) ppm; MS (ion spray): m/z 388 (M+H).

The following compounds are prepared from the compound of Example 72 using the procedures described above.

| Example | Name | m/z (M+H) |
|---------|---|------------------------|
| 286 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(5-chloro-thiophen-2-yloxy)-ethyl]-piperazin-2-one | 418, 420 Cl pattern |
| 287 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-1-methyl-1H-indol-2- | 435, 437 |

| | | |
|-----|---|---|
| | ylmethyl)-piperazin-2-one | Cl pattern |
| 288 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-thiophen-2-yl)-allyl]-piperazin-2-one | 414, 416 Cl pattern |
| 289 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(6-chloro-benzo[b]thiophen-2-yl)-allyl]-piperazin-2-one | 464, 466 Cl pattern |
| 290 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-4-methyl-thiophen-2-yl)-allyl]-piperazin-2-one | 428, 430 Cl pattern |
| 291 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-benzofuran-2-ylmethyl)-piperazin-2-one | 422, 424 Cl pattern |
| 292 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-chloro-1H-indol-5-ylmethyl)-piperazin-2-one | 421, 423 Cl pattern |
| 293 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-1H-indol-2-ylmethyl)-piperazin-2-one | 421, 423 Cl pattern |
| 294 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5,7-dichloro-1H-indol-2-ylmethyl)-piperazin-2-one | 455, 457 Cl pattern |
| 295 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-1H-indol-2-ylmethyl)-piperazin-2-one | 421, 423 Cl pattern |
| 296 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-p-tolyl-prop-2-ynyl)-piperazin-2-one | 386 |
| 297 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-m-tolyl-prop-2-ynyl)-piperazin-2-one | 386 |
| 298 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-phenyl)-prop-2-ynyl]-piperazin-2-one | 406, 408 Cl pattern |
| 299 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(3-chloro-phenyl)-prop-2-ynyl]-piperazin-2-one | 406, 408 Cl pattern |
| 300 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(2-chloro-phenyl)-prop-2-ynyl]-piperazin-2-one | 406 |
| 301 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-biphenyl-4-yl-prop-2-ynyl)-piperazin-2-one | 448 |
| 302 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4,5-dibromo-thiophen-2-yl)-allyl]-piperazin-2-one | 536, 538, 540 Br ₂ pattern |
| 303 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-biphenyl-3-yl-prop-2-ynyl)-piperazin-2-one | 448 |

| | | |
|-----|---|------------------------|
| 304 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(2,5-dichloro-thiophen-3-yl)-prop-2-ynyl]-piperazin-2-one | 446, 448 Cl pattern |
| 305 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(3-chloro-phenyl)-propyl]-piperazin-2-one | 410, 412 Cl pattern |
| 306 | 1,4-Bis-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one | 415 |
| 307 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(1H-pyrrolo[2,3-c]pyridin-2-ylmethyl)-piperazin-2-one | 388 |
| 308 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-nitro-thiophen-2-yl)-allyl]-piperazin-2-one | 425 |
| 309 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(6-chloro-pyridin-3-yl)-allyl]-piperazin-2-one | 409, 411 Cl pattern |
| 310 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one | 388 |
| 311 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-3-yl)-allyl]-piperazin-2-one | 414, 416 Cl pattern |
| 312 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-bromo-furan-2-yl)-allyl]-piperazin-2-one | 442, 444 Br pattern |
| 313 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[5-(5-methyl-thiophen-2-yl)-penta-2,4-dienyl]-piperazin-2-one | 420 |
| 314 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(2-chloro-benzo[b]thiophen-5-ylmethyl)-piperazin-2-one | 438, 440 Cl pattern |
| 315 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-methyl-thiophen-2-yl)-allyl]-piperazin-2-one | 394 |
| 316 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-methoxy-thiophen-2-yl)-allyl]-piperazin-2-one | 410 |
| 317 | 4-(1-Amino-7-chloro-isoquinolin-3-ylmethyl)-1-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one | 448, 450 Cl pattern |
| 318 | 2-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-yl]-N-(5-chloro-thiophen-2-yl)-acetamide | 431 |
| 319 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-isoquinolin-3-ylmethyl)-piperazin-2-one | 433, 435 Cl pattern |
| 320 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(3-chloro-phenyl)-2-(S)-hydroxy-ethyl]-piperazin-2-one | 412, 414 Cl pattern |
| 321 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(3-chloro-phenylsulfanyl)- | 428, 430 |

| | | |
|-----|---|------------------------|
| | ethyl]-piperazin-2-one | CI pattern |
| 322 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(2-methylene-1,1-dioxo-2,3-dihydro-1H-11 6-benzo[b]thiophen-3-yl)-piperazin-2-one | 470 |
| 323 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-nitro-phenyl)-allyl]-piperazin-2-one | 419 |
| 324 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(2-chloro-benzo[b]thiophen-6-ylmethyl)-piperazin-2-one | 438, 440 CI pattern |
| 325 | 2-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-yl]-N-(4-chloro-phenyl)-acetamide | 425, 427 CI pattern |
| 326 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[1-(4-chloro-phenyl)-pyrrolidin-3-yl]-piperazin-2-one | 437, 439 CI pattern |
| 327 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethyl]-piperazin-2-one | 402, 404 CI patten |
| 328 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-phenyl)-propyl]-piperazin-2-one | 410, 412 CI pattern |
| 329 | 2-[4-(4-Aminoquinazoline-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-3-(4-chlorophenyl)-acrylic acid | 452, 454 CI pattern |
| 330 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-1-hydroxy-isoquinolin-3-ylmethyl)-piperazin-2-one | 449, 451 CI pattern |
| 331 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-naphthalen-2-ylmethyl)-piperazin-2-one | 432, 434 CI pattern |
| 332 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-isoquinolin-3-ylmethyl-piperazin-2-one | 399 |
| 333 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[1-(3-chloro-phenyl)-pyrrolidin-3-yl]-piperazin-2-one | 437, 439 CI pattern |
| 334 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(1,7-dichloro-isoquinolin-3-ylmethyl)-piperazin-2-one | 467, 469 CI pattern |
| 335 | 4-(2-Amino-7-chloro-quinolin-3-ylmethyl)-1-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one | 448, 450 CI pattern |
| 336 | 1-(4-Aminoquinazolin-7-ylmethyl)-4-(5-chloro-benzo[b]thiophene-2-ylmethyl)piperazin-2-one. | 438, 440 CI pattern |
| 337 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(4-chloro-phenylsulfanyl)-ethyl]-piperazin-2-one | 428, 430 CI pattern |
| 338 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(6-chloro-benzo[b]thiophen- | 452, 454 |

| | | |
|-----|--|-------------------------------------|
| | 2-yl)-ethyl]-piperazin-2-one | Cl pattern |
| 339 | 1-(4-Aminoquinazolin-7-ylmethyl)-4-[2-(4-chloro-phenoxy)-ethyl]-piperazine-2-one | 412, 414 Cl pattern |
| 340 | 2-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-6-chloro-4H-benzo[1,4]thiazin-3-one | 469, 471 Cl pattern |
| 341 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(2,7-dichloro-quinolin-3-ylmethyl)-piperazin-2-on | 467, 469 Cl ₂ pattern |
| 342 | 2-[[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-yl]-(4-chloro-phenyl)-methyl]-acrylic acid ethyl ester | 480, 482 Cl pattern |
| 343 | 2-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-3-(4-chloro-phenyl)-acrylic acid ethyl ester | 480, 482 Cl pattern |
| 344 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-phenyl)-allyl]-piperazin-2-one | 408, 410 Cl pattern |
| 345 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(3-chloro-phenyl)-allyl]-piperazin-2-one | 408, 410 Cl pattern |
| 346 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-bromo-thiophen-2-yl)-allyl]-piperazin-2-one | 458, 460 Br pattern |
| 347 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-allyl]-piperazin-2-one | 458, 460 Br pattern |
| 348 | 3-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-7-fluoro-1H-quinolin-2-one | 433 |
| 349 | 3-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-6-chloro-1H-quinoxalin-2-one | 450, 452 Cl pattern |
| 350 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-1-methyl-1H-benzimidazol-2-ylmethyl)-piperazin-2-one | 436, 438 Cl pattern |
| 351 | 2-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-6-chloro-3H-quinazolin-4-one | 492, 494 Cl pattern |
| 352 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-thiophen-2-yl-propyl)-piperazin-2-one | 382 |
| 353 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-quinolin-3-ylmethyl)-piperazin-2-one | 432, 434 Cl pattern |
| 354 | 3-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-5,7-dichloro-1H-quinolin-2-one | 483, 485 Cl pattern |
| 355 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6,7-dichloro- | 472, 474 |

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| | benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | Cl ₂ pattern |
| 356 | 3-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-5-chloro-1H-quinolin-2-one | 449, 451 Cl pattern |
| 357 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-[2,3']bithiophenyl-5'-ylmethyl)-piperazin-2-one | 470, 472 Cl pattern |
| 358 | 4-(6-Amino-benzo[b]thiophen-2-ylmethyl)-1-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one | 419 |
| 359 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(2-chloro-quinolin-6-ylmethyl)-piperazin-2-one | 433, 435 Cl pattern |
| 360 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-bromo-1H-benzoimidazol-2-ylmethyl)-piperazin-2-one | 466, 468 Br pattern |
| 361 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-nitro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 449 |
| 362 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[5-(3-chloro-phenyl)-thiophen-2-ylmethyl]-piperazin-2-one | 464, 466 Cl pattern |
| 363 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-3-methoxy-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 468, 470 Cl pattern |
| 364 | 3-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-ylmethyl]-6-chloro-1H-quinolin-2-one | 449, 451 Cl pattern |
| 3653 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-trifluoromethyl-1H-benzoimidazol-2-ylmethyl)-piperazin-2-one | 456 |
| 366 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-methyl-[2,2']bithiophenyl-5-ylmethyl)-piperazin-2-one | 450 |
| 367 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-methyl-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 418 |
| 368 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-chloro-3,3'-dimethyl-[2,2']bithiophenyl-5-ylmethyl)-piperazin-2-one | 498, 500 Cl pattern |
| 369 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(3,5-dibromo-4-methoxy-phenyl)-[1,2,4]oxadiazol-5-ylmethyl]-piperazin-2-one | 602, 604, 606 Br ₂ pattern |
| 370 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-methyl-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 418 |
| 371 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(4-methyl-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 418 |

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| 372 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 438, 440 Cl pattern |
| 373 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-chloro-3'-methyl-[2,2']bithiophenyl-5-ylmethyl)-piperazin-2-one | 484, 486 Cl pattern |
| 374 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(1H-benzoimidazol-2-ylmethyl)-piperazin-2-one | 388 |
| 375 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-bromo-[2,2']bithiophenyl-5-ylmethyl)-piperazin-2-one | 514, 516 Br pattern |
| 376 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[5-(2,3-dihydro-benzo[1,4]dioxin-6-yl)-oxazol-2-ylmethyl]-piperazin-2-one | 473 |
| 377 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5,6-dichloro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 472, 474 Cl pattern |
| 378 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(4,5-dichloro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 472, 474 Cl pattern |
| 379 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-benzooxazol-2-ylmethyl)-piperazin-2-one | 423, 425 Cl pattern |
| 380 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-5-fluoro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 456, 458 Cl pattern |
| 381 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(4-chloro-5-fluoro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 456, 458 Cl pattern |
| 382 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-chloro-3-methyl-[2,2']bithiophenyl-5-ylmethyl)-piperazin-2-one | 484, 486 Cl pattern |
| 383 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-thieno[3,2-b]pyridin-2-ylmethyl)-piperazin-2-one | 439, 441 Cl pattern |
| 384 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5,6-dichloro-1H-benzoimidazol-2-ylmethyl)-piperazin-2-one | 456 |
| 385 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-benzooxazol-2-yl-benzyl)-piperazin-2-one | 464 |
| 386 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[5-(4-chloro-phenyl)-thiophen-2-ylmethyl]-piperazin-2-one | 464, 466 Cl pattern |
| 387 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-methyl-1H-benzoimidazol-2-ylmethyl)-piperazin-2-one | 402 |
| 388 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2,2']bithiophenyl-5-ylmethyl-piperazin-2-one | 435 |

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| 389 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(4-fluoro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 422 |
| 390 | 1-(4-Aminoquinazolin-7-ylmethyl)-4-(6-fluoro-benzo[b]thiophene-2-ylmethyl)piperazin-2-one. | 422 |
| 391 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[5-(1-methyl-5-trifluoro-methyl-1H-pyrazol-3-yl)-thiophen-2-ylmethyl]-piperazin-2-one | 501 |
| 392 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3,4-dimethyl-thieno[2,3-b]thiophen-2-ylmethyl)-piperazin-2-one | 438 |
| 393 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(4-chloro-3-methyl-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 452, 454 Cl pattern |
| 394 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-3-methyl-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 452, 454 Cl pattern |
| 395 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[5-(2-methyl-5-trifluoromethyl-2H-pyrazol-3-yl)thiophen-2-ylmethyl] piperazin-2-one | 502 |
| 396 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[5-(3-nitro-phenyl)-furan-2-ylmethyl]-piperazin-2-one | 459 |
| 397 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-thieno[3,2-b]pyridin-6-ylmethyl)-piperazin-2-one | 439, 441 Cl pattern |
| 398 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[5-(4-methoxy-phenyl)-thiophen-2-ylmethyl]-piperazin-2-one | 460 |
| 399 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(4-hydroxy-2-pyridin-2-yl-pyrimidin-5-ylmethyl)-piperazin-2-one | 443 |
| 400 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-fluoro-phenoxy)-benzyl]-piperazin-2-one | 458 |
| 401 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(4-chloro-phenyl)-thiazol-4-ylmethyl]-piperazin-2-one | 465, 467 Cl pattern |
| 402 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-bromo-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 482, 484 Br pattern |
| 403 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-benzo[b]thiophen-2-ylmethyl-piperazin-2-one | 404 |
| 404 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-chloro-[2,2']bithiophenyl-5-ylmethyl)-piperazin-2-one | 470, 472 Cl pattern |
| 405 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3,5-bis-trifluoromethyl-benzyl)-piperazin-2-one | 488 |

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| 406 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-biphenyl-4-ylmethyl-piperazin-2-one | 423 (M ⁺) |
| 407 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-naphthalen-2-ylmethyl-piperazin-2-one | 397 (M ⁺) |
| 408 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-benzo[b]thiophen-3-ylmethyl)-piperazin-2-one | 438, 440 Cl pattern |
| 409 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-thieno[2,3-b]pyridin-2-ylmethyl)-piperazin-2-one | 438, 440Cl pattern |

EXAMPLE 410. 1-(4-Aminoquinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-(E)-acryloyl]piperazin-2-one.

The title compound is prepared as described in EXAMPLE 123 using 1-(4-aminoquinazolin-7-ylmethyl)piperazine-2-one bishydrochloride, EXAMPLE 72, in place of 4-(2-oxopiperazin-1-ylmethyl)benzamidinium bistrifluoroacetate. ¹H NMR (d6-DMSO, 300 MHz) δ 9.77 (bs, 2H), 8.83 (s, 1H), 8.40 (dd, 1H), 7.68 (d, 1H), 7.65 (s, 1H), 7.58 (d, 2H), 7.15 (d, 2H), 4.80 (s, 2H), 4.33, 4.15 (m, 2H, rotamers), 3.70 (m, 2H), 3.49 (m, 2H). ESI MS, [M+H]⁺=456, 458 (Br pattern).

The following compounds are prepared from the compound of Example 72 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|---|------------------------|
| 411 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(4-chloro-thiophene-2-carbonyl)-piperazin-2-one | 402, 404 Cl pattern |
| 412 | 4-[3-(3-Amino-4-chloro-phenyl)-(E)-acryloyl]-1-(4-amino-quinazolin-7-ylmethyl)-piperazin-2-one | 437, 439 Cl pattern |
| 413 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-chloro-1H-indole-6-carbonyl)-piperazin-2-one | 435, 437 Cl pattern |
| 414 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]piperazin-2-one | 432, 434 Cl pattern |
| 415 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-bromo-thiophen-2-yl)-(E)-acryloyl]piperazin-2-one | 472, 474 Br pattern |
| 416 | 5-Chloro-thiophene-2-carboxylic acid {2-[4-(4-amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-yl]-2-oxo-ethyl}-amide | 459, 461 Cl pattern |
| 417 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-thiophen-2-yl)-(E)- | 428, 430 |

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| | acryloyl]-piperazin-2-one | CI pattern |
| 418 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-1H-indole-2-carbonyl)-piperazin-2-one | 435, 437 CI pattern |
| 419 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(6-chloro-benzo[b]thiophen-2-yl)-(E)-acryloyl]-piperazin-2-one | 478, 480 CI pattern |
| 420 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-(E)-acryloyl]-piperazin-2-one | 472, 474 Br pattern |
| 421 | 5-Chloro-thiophene-2-carboxylic acid {2-[4-(4-amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-yl]-1-methyl-2-oxo-ethyl}-amide | 473, 475 CI pattern |
| 422 | 5-Chloro-thiophene-2-carboxylic acid {3-[4-(4-amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-yl]-3-oxo-propyl}-amide | 473, 475 CI pattern |
| 423 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-phenoxy)-acetyl]-piperazin-2-one | 426, 428 CI pattern |
| 424 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-2-methyl-phenoxy)-acetyl]-piperazin-2-one | 440, 442 CI pattern |
| 425 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-chloro-[2,2']bithiophenyl-5-carbonyl)-piperazin-2-one | 484, 486 CI pattern |
| 426 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-propionyl]-piperazin-2-one | 430, 432 CI pattern |
| 427 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(3-chloro-phenyl)-(E)-acryloyl]-piperazin-2-one | 422, 424 CI pattern |
| 428 | N-[2-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-yl]-1-(5-chloro-thiophen-2-ylmethyl)-2-oxo-ethyl]-benzamide | 428, 430 CI pattern |
| 429 | N-[1-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carbonyl]-2-(5-chloro-thiophen-2-yl)-vinyl]-benzamide | 549, 550 CI pattern |
| 430 | N-[1-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carbonyl]-2-(5-chloro-thiophen-2-yl)-vinyl]-acetamide | 485, 487 CI pattern |
| 431 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-phenyl)-(E)-acryloyl]-piperazin-2-one | 422, 424 CI pattern |
| 432 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yl)-acetyl]-piperazin-2-one | 415, 417 CI pattern |
| 433 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-carbonyl)-piperazin-2-one | 451, 453 CI pattern |
| 434 | 2-[4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carbonyl]- | 483, 485 |

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| | 6-chloro-4H-benzo[1,4]thiazin-3-one | CI pattern |
| 435 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(6-chloro-benzo[b]thiophen-2-yl)-acetyl]-piperazin-2-one | 466, 468 CI pattern |

EXAMPLE 436. 4-(4-Aminoquinazolin-7-ylmethyl)-3-oxopiperazine-1-carboxylic acid 4-chloro-benzylamide.

To a solution of 1-(4-aminoquinazoline-7-ylmethyl)piperazine-2-one (25 mg, 0.097 mmol), EXAMPLE 72, in 1 mL of DMF is added 4-chloro-benzyl isocyanate (22 mg, 0.13 mmol, prepared as described in EXAMPLE 37). After stirring 1 h at room temperature, the solution is concentrated. The crude product is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 80% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to provide the title compound (36 mg, 0.067 mmol) as a white solid. ¹H NMR (d6-DMSO, 300 MHz) δ 9.76 (bs, 2H), 8.83 (s, 1H), 8.38 (d, 1H), 7.64 (d, 1H), 7.60 (s, 1H), 7.34 (d, 2H), 7.31 (m, 1H), 7.26 (d, 2H), 4.75 (s, 2H), 4.22 (d, 2H), 4.08 (s, 2H), 3.60 (m, 2H), 3.35 (m, 2H). ESI MS, [M+H]⁺=425,427 (CI pattern).

EXAMPLE 437. 4-(4-Aminoquinazolin-7-ylmethyl)-3-oxopiperazine-1-carboxylic acid (5-chloro-thiophen-2-ylmethyl)amide.

To a solution of (5-chloro-thiophen-2-yl)-acetic acid (0.18 g, 1.04 mmol), prepared as described in EXAMPLE 27 in 6 mL of dry CH₂Cl₂ is added Et₃N (0.15 mL g, 1.04 mmol) and diphenylphosphoryl azide (0.24 mL, 1.04 mmol). The mixture is stirred at room temperature for 2.5 h, then heated at 50°C for 2 hours. To the solution is added 1-(4-aminoquinazoline-7-ylmethyl)piperazine-2-one (0.10 g, 0.41 mmol), EXAMPLE 72, and Et₃N (0.15 mL g, 1.04 mmol) and the mixture is heated at 50°C for 2 h, then stirred at room temperature for 16 hours. The resulting mixture is concentrated. The crude product is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 60% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to provide the title compound (10 mg, 0.02 mmol) as a white solid. ¹H NMR (d6-DMSO, 300 MHz) δ 9.69 (bs, 2H), 8.80 (s, 1H), 8.48 (d, 1H), 7.61 (d, 1H), 7.60 (s, 1H), 7.41 (t, 1H), 6.90 (d, 1H), 6.80 (d, 1H), 4.77 (d, 2H), 4.30 (d, 2H), 4.10 (s, 2H), 3.61 (m, 2H), 3.38 (m, 2H). ESI MS, [M+H]⁺=431,433 (CI pattern).

EXAMPLE 438. 4-(4-Aminoquinazolin-7-ylmethyl)-3-oxopiperazine-1-carboxylic acid (5-chloro-thiophen-2-yl)amide.

A mixture of 5-chloro-thiophene-2-carbonyl azide (55 mg, 0.29 mmol, prepared as described in EXAMPLE 38) and 1-(4-aminoquinazoline-7-ylmethyl)piperazine-2-one (50 mg, 0.20 mmol), EXAMPLE 72, in 3 mL of dry toluene is heated at 105°C for 1 hours. The resulting

mixture is concentrated in vacuo. The crude product is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 60% CH₃CN/H₂O (0.1% TFA) and the appropriate product fractions are combined and lyophilized to provide the title compound (35 mg, 0.02 mmol) as a white solid. ¹H NMR (DMSO-d₆, 300 MHz) δ 10.04 (s, 1H), 9.71 (bs, 2H), 8.81 (s, 1H), 8.38 (dd, 1H), 7.64 (d, 1H), 7.61 (s, 1H), 6.77 (d, 1H), 6.42 (d, 1H), 4.76 (s, 2H), 4.21 (s, 2H), 3.73 (m, 2H), 3.40 (m, 2H). ESI MS, [M+H]⁺=417,419 (Cl pattern).

The following compounds are prepared from the compound of Example 72 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|-------------------------------------|
| 439 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carboxylic acid (4-chloro-thiophen-2-yl)-amide | 417, 419 Cl pattern |
| 440 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carboxylic acid (5-bromo-thiophen-2-yl)-amide | 461, 463 Br pattern |
| 441 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carboxylic acid (3-amino-4-chloro-phenyl)-amide | 426, 428 Cl pattern |
| 442 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carboxylic acid (4-bromo-phenyl)-amide | 455, 457 Br pattern |
| 443 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carboxylic acid (4-chloro-phenyl)-amide | 411, 413 Cl pattern |
| 444 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carboxylic acid (4-methoxy-phenyl)-amide | 407 |
| 445 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carboxylic acid (3,4-dichloro-phenyl)-amide | 445, 447 Cl ₂ pattern |

EXAMPLE 446. 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carboxylic acid 5-chloro-thiophen-2-ylmethyl ester.

To a solution of 5-chloro-2-thiophene-methanol (0.10 g, 0.67 mmol, prepared by NaBH₄ reduction of 5-chloro-2-thiophene-carboxaldehyde) in 6 mL of CH₂Cl₂ is added 1,1'-carbonyldiimidazole (0.11 g, 0.67 mmol). The mixture is stirred at room temperature for 3 hours. Then 1-(4-aminoquinazoline-7-ylmethyl)piperazine-2-one (0.17 g, 0.67 mmol, EXAMPLE 72) and a catalytic amount of DMAP is added to the solution and the resulting mixture is heated at 35°C for 18 hours. The mixture is dissolved in water/MeOH and the crude product is purified by RP-HPLC eluting in a gradient of 10% CH₃CN/H₂O (0.1% TFA) to 100%

CH₃CN. The appropriate fractions are combined and lyophilized to provide the title compound as a white solid. ESI MS, [M+H]⁺=432,434 (CI pattern).

The following compounds are prepared from the compound of Example 72 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|------------------------|
| 447 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazin-1-carboxylic acid 6-chloro-benzooxazol-2-ylmethyl ester | 467, 469 CI pattern |
| 448 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-piperazine-1-carboxylic acid 1-(3-chloro-phenyl)-pyrrolidin-3-yl ester | 481, 483 CI pattern |

EXAMPLE 449. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-isoquinolin-3-ylmethyl)-3-(S)-methyl-piperazin-2-one.

To a solution of 1-(4-amino-quinazoline-7-ylmethyl)-3-methyl-piperazine-2-one, EXAMPLE 80, (0.06g, 0.2mmol) in 2 mL of DMF is added 3-bromomethyl-7-chloroisoquinoline, EXAMPLE 11, 0.052g, 0.20mmol), and K₂CO₃ (0.08 g, 0.06 mmol). After 16 h, the reaction mixture is concentrated to dryness. The crude product is purified by RP-HPLC eluting with a gradient of 5%CH₃CN/H₂O (0.1% TFA) to 50%CH₃CN/H₂O (0.1% TFA). The product fractions are lyophilized to give the title compound as a tris(trifluoroacetic acid) salt (0.06g, 0.08 mmol) as a white solid. ¹H NMR (d₆-DMSO, 300 MHz) δ 9.79 (bs, 2H), 9.40 (s, 1H), 8.73 (s, 1H), 8.33 (d, 1H), 8.25 (s, 1H), 8.06 (s, 1H), 8.00 (d, 1H), 7.79 (d, 1H), 7.60 (m, 2H), 4.80 (AB, 2H), 4.72 (AB, 2H), 4.28 (m, 1H), 3.54 (m, 4H), 1.96 (d, 3H). MS (ion spray) 447, 449, (CI pattern). Elemental analysis C₂₈H₂₅ClF₆N₆O₆·3CF₃CO₂H·0.28H₂O, cal C=45.38%, H=3.35%, N=10.58%; found C=45.38, H=3.35%, N=10.63%.

EXAMPLE 450. 4-(4-Amino-quinazolin-7-ylmethyl)-4-(3-chloro-1H-indol-6-ylmethyl)-3-(S)-methyl-piperazin-2-one.

The title compound is prepared as described in EXAMPLE 274 using 1-(4-amino-quinazoline-7-ylmethyl)-3-methyl-piperazine-2-one, EXAMPLE 80. ¹H NMR (DMSO-d₆, 300 MHz) δ 9.79 (bs, 2H), 8.82 (s, 1H), 8.39 (d, 1H), 7.61 (m, 3H), 7.57 (d, 1H), 7.52 (d, 1H), 7.49 (d, 1H), 7.20 (d, 1H), 7.10 (d, 1H), 4.75 (AB, 2H), 4.57 (m, 1H), 4.23 (m, 1H), 3.97 (m, 1H), 3.50 (m, 3H), 1.65 (d, 3H). ESI MS, [M+H]⁺= 435,437 (CI pattern). Anal. (C₂₃H₂₃ClN₆O₂·2.15TFA·0.25H₂O) C, H, N.

The following compounds are prepared from the compound of Example 80 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|---|------------------------|
| 451 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-thiophen-2-yl)-allyl]-3-(S)-methyl-piperazin-2-one | 428, 430 CI pattern |
| 452 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(6-chloro-benzo[b]thiophen-2-yl)-allyl]-3-(S)-methyl-piperazin-2-one | 478, 480 CI pattern |
| 453 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-propyl]-3-(S)-methyl-piperazin-2-one | 429, 431 CI pattern |
| 454 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-1H-indol-2-ylmethyl)-3-(S)-methyl-piperazin-2-one | 435, 437 CI pattern |
| 455 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-but-2-enyl]-3-(S)-methyl-piperazin-2-one | 442, 444 CI pattern |
| 456 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-chloro-[2,2']bithiophenyl-5-ylmethyl)-3-(S)-methyl-piperazin-2-one | 483 (M+) (EI) |
| 457 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-1H-benzoimidazol-2-ylmethyl)-3-(S)-methyl-piperazin-2-one | 536, 538 CI pattern |
| 458 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3-(S)-methyl-piperazin-2-one | 428, 430 CI pattern |
| 459 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-naphthalen-2-ylmethyl)-3-(S)-methyl-piperazin-2-one | 446, 448 CI pattern |
| 460 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-thieno[2,3-b]pyridin-2-ylmethyl)-3-(S)-methyl-piperazin-2-one | 453, 455 CI pattern |
| 461 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-3-(S)-methyl-piperazin-2-one | 452, 454 CI pattern |
| 462 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-benzo[b]thiophen-2-ylmethyl)-3-(S)-methyl-piperazin-2-one | 452, 454 CI pattern |
| 463 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-benzo[b]thiophen-2-ylmethyl)-3-(R)-methyl-piperazin-2-one | 452, 454 CI pattern |
| 464 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-3-(R)-methyl-piperazin-2-one | 452, 454 CI pattern |

EXAMPLE 465 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-thiophen-2-yl)-acryloyl]-3-(S)-methyl-piperazin-2-one.

The title compound is prepared as described in EXAMPLE 123, using 1-(4-amino-quinazoline-7-ylmethyl)-3-methyl-piperazine-2-one, EXAMPLE 80, and 3-(4-chloro-thiophen-2-

yl)-(E)-acrylic acid, EXAMPLE 26. ¹H NMR (d₆-DMSO, 300 MHz) δ 9.74 (bs, 2H), 8.82 (s, 1H), 8.40 (d, 1H), 7.62 (m, 5H), 7.05 (d, 1H), 4.92 (m, 1H), 4.80 (m, 2H), 4.73 (m, 1H), 4.50 (m, 1H), 3.40 (m, 2H), 1.42 (m, 3H). ESI MS, [M+H]⁺ = 442, 444 (CI pattern).

- 5 The following compounds are prepared from the compound of Example 80 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|------------------------|
| 466 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-3-yloxy)-acetyl]-3-(S)-methyl-piperazin-2-one | 446, 448 CI pattern |
| 467 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-methyl-piperazin-2-one | 446, 448 CI pattern |
| 468 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-bromo-thiophen-2-yl)-acryloyl]-3-(S)-methyl-piperazin-2-one | 486, 488 Br pattern |
| 469 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-chloro-1H-indole-6-carbonyl)-3-(S)-methyl-piperazin-2-one | 449, 451 CI pattern |
| 470 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-isoquinoline-3-carbonyl)-3-(S)-methyl-piperazin-2-one | 461, 463 CI pattern |
| 471 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-methyl-piperazin-2-one | 446, 448 CI pattern |
| 472 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-3-(S)-methyl-piperazin-2-one | 486, 488 Br pattern |
| 473 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-phenoxy)-acetyl]-3-(S)-methyl-piperazin-2-one | 440, 442 CI pattern |
| 474 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5'-chloro-[2,2']bithiophenyl-5-carbonyl)-3-(S)-methyl-piperazin-2-one | 498, 500 CI pattern |
| 475 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-but-2-enoyl]-3-(S)-methyl-piperazin-2-one | 456, 458 CI pattern |
| 476 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-carbonyl)-3-(S)-methyl-piperazin-2-one | 466, 468 CI pattern |
| 477 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-(S)-methyl-piperazin-2-one | 442, 444 CI pattern |

EXAMPLE 478. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-propyl]-3-(S)-ethyl-piperazin-2-one.

- The title compound is prepared as described in EXAMPLE 278 using 1-(4-aminoquinazoline-7-ylmethyl)-3-ethyl-piperazine-2-one, EXAMPLE 77 and 3-(5-chloro-
- 10

thiophen-2-yl)-propionaldehyde, EXAMPLE 28. ¹H NMR (d6-DMSO + 1 drop TFA, 300 MHz) δ 9.80 (bs, 2H), 8.79 (s, 1H), 8.32 (d, 1H), 7.58 (m, 2H), 6.88 (d, 1H), 6.70 (d, 1H), 4.72 (AB, 2H), 4.00 (m, 1H), 3.72 (m, 1H), 3.48 (m, 2H), 3.23 (m, 3H), 2.72 (m, 2H), 1.96 (m, 4H), 0.98 (m, 3H). MS (ion spray), m/z, (M+H) = 444, 446 (CI pattern).

5

The following compounds are prepared from the compound of Example 77 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|------------------------|
| 479 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-thiophen-2-yl)-allyl]-3-(S)-ethyl-piperazin-2-one | 442, 444 CI pattern |
| 480 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-but-2-enyl]-3-(S)-ethyl-piperazin-2-one | 456, 458 CI pattern |
| 481 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-isoquinolin-3-ylmethyl)-3-(S)-ethyl-piperazin-2-one | 461, 463 CI pattern |
| 482 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3-(S)-ethyl-piperazin-2-one | 442, 444 CI pattern |
| 483 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-naphthalen-2-ylmethyl)-3-(S)-ethyl-piperazin-2-one | 460, 462 CI pattern |
| 484 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-3-(S)-ethyl-piperazin-2-one | 466, 468 CI pattern |
| 485 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-thieno[2,3-b]pyridin-2-ylmethyl)-3-(S)-ethyl-piperazin-2-one | 467, 469 CI pattern |

EXAMPLE 486. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-(S)-ethyl-piperazin-2-one.

10 The title compound is prepared as described in EXAMPLE 123, using 1-(4-aminoquinazoline-7-ylmethyl)-3-ethyl-piperazine-2-one, EXAMPLE 77 and 3-(5-chloro-thiophen-2-yl)-(E)-acrylic acid, EXAMPLE 25. ¹H NMR (d6-DMSO + 1 drop TFA, 300 MHz) δ 9.78 (bs, 2H), 8.79 (s, 1H), 8.37 (d, 1H), 7.65 (m, 2H), 7.50 (s, 1H), 7.41 (m, 1H), 7.11 (d, 1H), 6.98 (d, 1H), 4.88 (m, 2H), 4.60 (m, 1H), 4.31 (m, 1H), 3.52 (m, 1H), 3.30 (m, 2H), 1.96 (m, 2H),
 15 0.88 (m, 3H). MS (ion spray), m/z, (M+H) = 456, 458 (CI pattern). Elemental analysis, cal C₂₂H₂₂ClN₅O₂S·1.5C₂H₅F₃O₂ %C=47.89, %H=3.78, %N=11.17; found %C=47.34, %H=4.00, %N=11.12.

20 The following compounds are prepared from the compound of Example 77 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|---|---|
| 487 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-thiophen-2-yloxy)-acetyl]-(S)-3-ethyl-piperazin-2-one | 460, 462 Cl pattern |
| 488 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-3-yloxy)-acetyl]-(S)-3-ethyl-piperazin-2-one | 460, 462 Cl pattern |
| 489 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-3-yl)-acryloyl]-(S)-3-ethyl-piperazin-2-one | 456, 458 Cl pattern |
| 490 | 2-(2-[2-[4-(4-Amino-quinazolin-7-ylmethyl)-(S)-2-ethyl-3-oxo-piperazin-1-yl]-2-oxo-ethoxy]-5-chloro-thiophen-3-yl)-acetamide | 517, 519 Cl pattern |
| 491 | (2-[2-[4-(4-Amino-quinazolin-7-ylmethyl)-(S)-2-ethyl-3-oxo-piperazin-1-yl]-2-oxo-ethoxy]-5-chloro-thiophen-3-yl)-acetic acid | 518, 520 Cl pattern |
| 492 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(2,3-dichloro-benzo[b]thiophene-6-carbonyl)-(S)-3-ethyl-piperazin-2-one | 514, 516, 518 Cl ₂ pattern |
| 493 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(2-chloro-benzo[b]thiophene-6-carbonyl)-(S)-3-ethyl-piperazin-2-one | 480, 482 Cl pattern |
| 494 | (2-[2-[4-(4-Amino-quinazolin-7-ylmethyl)-(S)-2-ethyl-3-oxo-piperazin-1-yl]-2-oxo-ethoxy]-5-chloro-thiophen-3-yl)-acetic acid ethyl ester | 546, 548 Cl pattern |
| 495 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3,5-dichloro-thiophen-2-yloxy)-acetyl]-(S)-3-ethyl-piperazin-2-one | 494, 496 Cl pattern |
| 496 | (2-[2-[4-(4-Amino-quinazolin-7-ylmethyl)-(S)-2-ethyl-3-oxo-piperazin-1-yl]-2-oxo-ethoxy]-5-chloro-thiophen-3-yl)-acetic acid methyl ester | 532, 534 Cl pattern |
| 497 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-chloro-1H-indole-6-carbonyl)-(3S)-ethyl-piperazin-2-one | 463, 465 |
| 498 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-isoquinoline-3-carbonyl)-3-(S)-ethyl-piperazin-2-one | 475, 477 Cl pattern |
| 499 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-ethyl-piperazin-2-one | 460, 462 Cl pattern |
| 500 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-bromo-thiophen-2-yl)-acryloyl]-3-(S)-ethyl-piperazin-2-one | 500, 502 Br pattern |

| | | |
|-----|---|------------------------|
| 501 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-thiophen-2-yl)-acryloyl]-3-(S)-ethyl-piperazin-2-one | 456, 458 CI pattern |
| 502 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-3-(S)-ethyl-piperazin-2-one | 500, 502 Br pattern |
| 503 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-propionyl]-3-(S)-ethyl-piperazin-2-one | 458, 460 CI pattern |
| 504 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[1-(4-chloro-phenyl)-1H-pyrrole-2-carbonyl]-3-(S)-ethyl-piperazin-2-one | 489, 491 CI pattern |
| 505 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-phenylsulfanyl)-acetyl]-3-(S)-ethyl-piperazin-2-one | 470, 472 CI pattern |
| 506 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-but-2-enoyl]-3-(S)-ethyl-piperazin-2-one | 470, 472 CI pattern |
| 507 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-phenoxy)-acetyl]-3-(S)-ethyl-piperazin-2-one | 454, 456 CI pattern |
| 508 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-phenyl)-acryloyl]-3-(S)-ethyl-piperazin-2-one | 450, 452 CI pattern |
| 509 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-1H-indole-2-carbonyl)-3-(S)-ethyl-piperazin-2-one | 463, 465 CI pattern |
| 510 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-phenyl)-propionyl]-3-(S)-ethyl-piperazin-2-one | 452, 454 CI pattern |
| 511 | 1-(4-Amino-quinazolin-7-ylmethyl)-3-(S)-ethyl-4-[3-(4-methoxy-phenyl)-propionyl]-piperazin-2-one | 448 |
| 512 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-carbonyl)-3-(S)-ethyl-piperazin-2-one | 480, 482 CI pattern |

EXAMPLE 513. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-propyl-piperazin-2-one.

The title compound is prepared as described in EXAMPLE 123, using 1-(4-aminoquinazoline-7-ylmethyl)-3-propyl-piperazine-2-one, EXAMPLE 78 and 5-chloro-2-

thienyloxyacetic acid, EXAMPLE 24. ¹H NMR (d6-DMSO, 300 MHz) δ 9.78 (bs, 2H), 8.81 (s, 1H), 8.35 (d, 1H), 7.60 (m, 2H), 7.51 (s, 1H), 6.69 (m, 1H), 6.21 (d, 1H), 4.91 (AB, 2H), 4.72 (m, 2H), 3.84 (m, 1H), 3.52 (m, 2H), 3.23 (m, 1H), 1.80 (m, 2H), 1.24 (m, 2H), 0.82 (m, 3H). MS (ion spray), m/z, 474, 476, (M+H) (CI pattern). Elemental analysis, cal C₂₂H₂₂ClN₅O₂S·C₂H₅F₃O₂·1.15H₂O %C=47.31, %H=4.52, %N=11.50; found %C=47.39,

%H=4.140, %N=11.19.

EXAMPLE 514. 4-[3-(6-Amino-pyridin-3-yl)-acryloyl]-1-(4-amino-quinazolin-7-ylmethyl)-3-(S)-propyl-piperazin-2-one.

The title compound is prepared as described in EXAMPLE 123, using 1-(4-aminoquinazolin-7-ylmethyl)-3-propyl-piperazine-2-one, EXAMPLE 78 and 3-(6-amino-pyridin-3-yl)-acrylic acid, EXAMPLE 36. ¹H NMR (d6-DMSO, 300 MHz) δ 9.73 (bs, 2H), 8.81 (s, 1H), 8.36 (m, 2H), 8.22 (m, 3H), 7.62 (d, 1H), 7.52 (m, 1H), 7.39 (m, 1H), 7.21 (m, 1H), 6.91 (d, 1H), 5.00 (m, 1H), 4.78 (m, 1H), 4.60 (m, 2H), 4.34 (m, 1H), 3.30 (m, 2H), 1.87 (m, 2H), 1.24 (m, 2H), 0.90 (m, 3H). MS (ion spray), m/z, 446, 448 (M+H), (CI pattern).

The following compounds are prepared from the compound of Example 78 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|---|--|
| 515 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(2,5-dichloro-thiophen-3-yloxy)-acetyl]-3-(S)-propyl-piperazin-2-one | 508, 509, 511, Cl ₂ pattern |
| 516 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-propyl-piperazin-2-one | 474, 476 Cl pattern |
| 517 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-3-(S)-propyl-piperazin-2-one | 514, 516 Br pattern |
| 518 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-thiophen-2-yl)-acryloyl]-3-(S)-propyl-piperazin-2-one | 470, 472 Cl pattern |
| 519 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3-chloro-phenoxy)-acetyl]-3-(S)-propyl-piperazin-2-one | 468, 470 Cl pattern |
| 520 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-3-yloxy)-acetyl]-3-(S)-propyl-piperazin-2-one | 474, 476 Cl pattern |
| 521 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3-chloro-5-methoxy-phenoxy)-acetyl]-3-(S)-propyl-piperazin-2-one | 498, 500 Cl pattern |
| 522 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-3-yl)-acryloyl]-3-(S)-propyl-piperazin-2-one | 470, 472 Cl pattern |
| 523 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-(S)-propyl-piperazin-2-one | 470, 472 Cl pattern |

EXAMPLE 524. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3-(S)-methoxymethyl-piperazin-2-one.

The title compound is prepared as described in EXAMPLE 278 using 1-(4-amino-quinazolin-7-ylmethyl)-3-methoxymethyl-piperazine-2-one, EXAMPLE 75 and 2-(3-bromo-(E)-

propenyl)-5-chloro-thiophene EXAMPLE 17. ¹H NMR (d6-DMSO, 300 MHz) δ 9.74 (bs, 2H), 8.80 (s, 1H), 8.38 (d, 1H), 7.69 (m, 2H), 7.02 (dd, 1H), 6.84 (d, 1H), 6.02 (m, 1H), 4.76 (AB, 2H), 3.86 (m, 4H), 3.30 (s, 3H), 3.23 (m, 2H), 3.02 (m, 2H). MS (ion spray), m/z, 458, 460, (M+H) (Cl pattern). Elemental analysis, cal C₂₂H₂₄ClN₅O₂S·2C₂HF₃O₂·1.45H₂O %C=43.85, %H=4.09, %N=9.83; found %C=43.92, %H=3.61, %N=9.63.

The following compounds are prepared from the compound of Example 75 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|------------------------|
| 525 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3-chloro-1H-indol-6-ylmethyl)-3-(S)-methoxymethyl-piperazin-2-one | 465, 467 |
| 526 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(5-chloro-thiophen-2-yloxy)-ethyl]-3-(S)-methoxymethyl-piperazin-2-one | 446, 448 Cl pattern |
| 527 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-1H-indol-2-ylmethyl)-3-(S)-methoxymethyl-piperazin-2-one | 446, 448 Cl pattern |
| 528 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-isoquinolin-3-ylmethyl)-3-(R)-methoxymethyl-piperazin-2-one | 477, 479 Cl pattern |
| 529 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-isoquinolin-3-ylmethyl)-3-(S)-methoxymethyl-piperazin-2-one | 477, 479 Cl pattern |
| 530 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-naphthalen-2-ylmethyl)-3-(S)-methoxymethyl-piperazin-2-one | 476, 478 Cl pattern |
| 531 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-3-(S)-methoxymethyl-piperazin-2-one | 482, 484 Cl pattern |

EXAMPLE 532. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one.

To a solution of 4-(4-amino-quinazoline-7-ylmethyl)-2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, EXAMPLE 75, (0.69g, 2.29mmol) in 9mL of DMF is added N,N-diisopropylethyl amine (0.89g, 6.87mmol), TBTU (0.76g, 2.36mmol), and 5-chloro-2-thienyloxyacetic acid, EXAMPLE 24, (0.40g, 2.08mmol). The solution is stirred for 16 hours. After this time the solution is concentrated. The crude material is purified by RP-HPLC eluting with a gradient of 10%CH₃CN/H₂O (0.1%TFA) to 80%CH₃CN/H₂O (0.1%TFA). The product fractions are lyophilized to give the product as a white solid (1.0g, 1.57mmol). ¹H NMR (d6-DMSO, 300MHz) δ 9.70 (bs, 2H), 8.78 (s, 1H), 8.29 (m, 1H), 7.55 (m, 2H), 6.72 (m, 1H), 6.22 (m, 1H), 4.80 (m, 4H), 3.78 (m, 4H), 3.59 (m, 3H), 3.31 and 3.2 (s, 3H rotational isomers). MS (ion

spray) M+H=476. Elemental Analysis: C₂₁H₂₂ClN₅O₄S·1.4CF₃CO₂H cal: C=45.03%, H=3.68%, N=11.04%; found C=44.98%, H=3.71%, N=11.02%.

EXAMPLE 533. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-1H-benzoimidazole-2-carbonyl)-3-(S)-methoxymethyl-piperazin-2-one.

To a solution of 4-(4-amino-quinazolin-7-ylmethyl)-2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid benzyl ester, EXAMPLE 75, (20 mg, 0.066 mmol) in 1.5 mL of DMF is added TBTU (923.4 mg, 0.073 mmol), diisopropylethylamine (0.013 ml, 0.073 mmol) and 6-chloro-1H-benzoimidazole-2-carboxylic acid (prepared from literature in Eur.J.med.Chem. 1993, 28, 71) (14.3 mg, 0.073 mmol). The resulting mixture is left to stir at room temperature overnight. The crude mixture is directly purified by reverse phase HPLC (10-70% ACN/H₂O). The product (30.1 mg, 55%) is isolated as a white powder. C₂₃H₂₂ClN₇O₃ MS m/z: 480, 481. Anal. calcd. for C₂₃H₂₂ClN₇O₃·2C₂HF₃O₂: C, 45.81; H, 3.42; N, 13.85. Found C, 45.19; H, 3.59; N, 13.76.

The following compounds are prepared from the compound of Example 75 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|--------------------------------------|
| 534 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 476, 478 Cl pattern |
| 535 | 4-[3-(4-Amino-phenyl)-acryloyl]-1-(4-amino-quinazolin-7-ylmethyl)-3-(S)-methoxymethyl-piperazin-2-one | 447 |
| 536 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(3H-imidazol-4-yl-acryloyl)-3-(S)-methoxymethyl-piperazin-2-one | |
| 537 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(2,5-dichloro-thiophen-3-yloxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 510, 512, Cl ₂ pattern |
| 538 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-1H-benzoimidazole-2-carbonyl)-3-(S)-methoxymethyl-piperazin-2-one | 480, 482 Cl pattern |
| 539 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(5-chloro-thiophene-2-carbonyl)-3-(S)-methoxymethyl-piperazin-2-one | 446, 448 Cl pattern |
| 540 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-bromo-furan-2-yl)-acryloyl]-3-(S)-methoxymethyl-piperazin-2-one | 500, 502 Br pattern |
| 541 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-phenyl)-acryloyl]-3-(S)-methoxymethyl-piperazin-2-one | 510, 512 Br pattern |
| 542 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-phenyl)-acryloyl]- | 466, 468 |

| | | |
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| | 3-(S)-methoxymethyl-piperazin-2-one | Cl pattern |
| 543 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(3-bromo-phenyl)-acryloyl]-3-(S)-methoxymethyl-piperazin-2-one | 576, 578 Br pattern |
| 544 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(3-chloro-phenyl)-acryloyl]-3-(S)-methoxymethyl-piperazin-2-one | 466, 468 Cl pattern |
| 545 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-bromo-thiophen-2-yl)-acryloyl]-3-(S)-methoxymethyl-piperazin-2-one | 576, 578 Br pattern |
| 546 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-3-yloxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 476, 478 Cl pattern |
| 547 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-pyridin-3-yloxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 471, 473 Cl pattern |
| 548 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(6-chloro-pyridin-2-yloxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 471, 473 Cl pattern |
| 549 | 4-[3-(6-Amino-pyridin-3-yl)-acryloyl]-1-(4-amino-quinazolin-7-ylmethyl)-3-(S)-methoxymethyl-piperazin-2-one | 448 |
| 550 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3-chloro-5-methoxy-phenoxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 500, 502 Cl pattern |
| 551 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-3-yl)-acryloyl]-3-(S)-methoxymethyl-piperazin-2-one | 472, 474 Cl pattern |
| 552 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(2,5-dichloro-phenoxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 504, 506, 508 Cl ₂ pattern |
| 553 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-fluoro-thiophen-2-yloxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 460 |
| 554 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3-fluoro-phenoxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 453 |
| 555 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(3-chloro-phenoxy)-propionyl]-3-(S)-methoxymethyl-piperazin-2-one | 484, 486 Cl pattern |
| 556 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(6-chloro-pyridin-3-yloxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 471, 473 Cl pattern |
| 557 | 1-(4-Amino-quinazolin-7-ylmethyl)-3-(S)-methoxymethyl-4-[(4-trifluoromethylsulfanyl-phenoxy)-acetyl]-piperazin-2-one | 536 |
| 558 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3-chloro-phenylamino)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 469, 471 Cl pattern |

| | | |
|-----|--|---|
| 559 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-phenylamino)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 469, 471 CI pattern |
| 560 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3-chloro-phenoxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 471, 473 CI pattern |
| 561 | (2-{2-[4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-3-oxo-piperazin-1-yl]-2-oxo-ethoxy}-5-chloro-thiophen-3-yl)-acetic acid | 534, 536 CI pattern |
| 562 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-ylsulfanyl)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 492, 494 CI pattern |
| 563 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(6-chloro-pyridin-3-ylamino)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 470, 472 CI pattern |
| 564 | 2-(2-{2-[4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-3-oxo-piperazin-1-yl]-2-oxo-ethoxy}-5-chloro-thiophen-3-yl)-acetic acid ethyl ester | 533, 535 CI pattern |
| 565 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(2-chloro-benzo[b]thiophene-6-carbonyl)-3-(S)-methoxymethyl-piperazin-2-one | 496, 498 CI pattern |
| 566 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(2,3-dichloro-benzo[b]thiophene-6-carbonyl)-3-(S)-methoxymethyl-piperazin-2-one | 530, 532, 534 Cl ₂ pattern |
| 567 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3,5-dichloro-thiophen-2-yloxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 510, 512, 514 Cl ₂ pattern |
| 568 | (2-{2-[4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-3-oxo-piperazin-1-yl]-2-oxo-ethoxy}-5-chloro-thiophen-3-yl)-acetic acid methyl ester | 548, 550 CI pattern |
| 569 | (2-{2-[4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-3-oxo-piperazin-1-yl]-2-oxo-ethoxy}-5-chloro-thiophen-3-yl)-acetic acid ethyl ester | 562, 564 CI pattern |
| 570 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(2-chloro-pyridin-3-ylamino)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 470, 472 CI pattern |
| 571 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(2,3-dichloro-phenoxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 504, 506, 508 Cl ₂ pattern |
| 572 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-fluoro-phenoxy)-acetyl]-3- | 454 |

| | | |
|-----|---|---|
| | (S)-methoxymethyl-piperazin-2-one | |
| 573 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-2-methyl-phenoxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 484, 486 Cl pattern |
| 574 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(2,4-dichloro-phenoxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 504, 506, 508 Cl ₂ pattern |
| 575 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-isoquinoline-3-carbonyl)-3-(S)-methoxymethyl-piperazin-2-one | 491, 493 Cl pattern |
| 576 | (1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-3-(S)-methoxymethyl-piperazin-2-one | 516, 518 Br pattern |
| 577 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-chloro-thiophen-2-yl)-acryloyl]-3-(S)-methoxymethyl-piperazin-2-one | 472, 474 Cl pattern |
| 578 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-(R)-methoxymethyl-piperazin-2-one | 472, 474 Cl pattern |
| 579 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-(S)-methoxymethyl-piperazin-2-one | 472, 474 Cl pattern |
| 580 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-carbonyl)-3-(S)-methoxymethyl-piperazin-2-one | 496, 498 Cl pattern |
| 581 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-phenoxy)-acetyl]-3-(S)-methoxymethyl-piperazin-2-one | 470, 472 Cl pattern |

EXAMPLE 582. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(6-chloro-pyridin-3-yloxy)-acetyl]-3-(S)-ethoxymethyl-piperazin-2-one.

The title compound is prepared as described in EXAMPLE 123, using 1-(4-aminoquinazoline-7-ylmethyl)-3-ethoxymethyl-piperazine-2-one, EXAMPLE 79 and, (6-chloro-pyridin-3-yloxy)-acetic acid, prepared similarly to the procedure described in EXAMPLE 29. ¹H NMR (d6-DMSO, 300 MHz) δ 9.73 (bs, 2H), 8.81 (s, 1H), 8.37 (m, 1H), 8.10 (m, 1H), 7.61 (m, 2H), 7.40 (m, 2H), 4.98 (m, 2H), 4.65 (m, 2H), 4.50 (m, 1H), 3.91 (m, 1H), 3.75 (m, 1H), 3.59 (m, 2H), 3.31 (m, 2H), 1.07 (m, 3H). MS (ion spray), m/z, 485, 487 (M+H), (Cl pattern).

10 The following compounds are prepared from the compound of Example 79 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|-----------|
| 583 | 1-(4-Amino-quinazolin-7-ylmethyl)-3-(S)-ethoxymethyl-4-[(3-fluoro-phenoxy)-acetyl]-piperazin-2-one | 454 |

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|-----|--|------------------------|
| 584 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-(S)-ethoxymethyl-piperazin-2-one | 486, 488 CI pattern |
| 585 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(2-chloro-pyridin-3-ylamino)-acetyl]-3-(S)-ethoxymethyl-piperazin-2-one | 484, 486 CI pattern |
| 586 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(6-chloro-pyridin-3-ylamino)-acetyl]-3-(S)-ethoxymethyl-piperazin-2-one | 484, 486 CI pattern |
| 587 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-ethoxymethyl-piperazin-2-one | 490, 492 CI pattern |

The following compounds are prepared from the compounds of Examples 81-85 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|---|------------------------|
| 588 | 1-(4-Amino-quinazolin-7-ylmethyl)-3-(S)-benzyl-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-piperazin-2-one | 518, 520 CI pattern |
| 589 | 1-(4-Amino-quinazolin-7-ylmethyl)-3-(S)-benzyl-4-(6-chloro-benzo[b]thio-phen-2-carbonyl)-piperazin-2-one | 542, 544 CI pattern |
| 590 | 1-(4-Amino-quinazolin-7-ylmethyl)-3-(S)-benzyl-4-[3-(5-chloro-thiophen-2-yl)-allyl]-piperazin-2-one | 504, 506 CI pattern |
| 591 | 1-(4-Amino-quinazolin-7-ylmethyl)-3-(S)-benzyl-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-piperazin-2-one | 528, 530 CI pattern |
| 592 | 1-(4-Amino-quinazolin-7-ylmethyl)-3-(S)-benzyl-4-[(4-chloro-phenoxy)-acetyl]-piperazin-2-one | 516, 518 CI pattern |
| 593 | 1-(4-Amino-quinazolin-7-ylmethyl)-3-(S)-benzyl-4-(6-chloro-naphthalen-2-ylmethyl)-piperazin-2-one | 522, 524 CI pattern |
| 594 | 1-(4-Amino-quinazolin-7-ylmethyl)-3-(S)-benzyl-4-[3-(5-chloro-thiophen-2-yl)-propyl]-piperazin-2-one | 506, 508 CI pattern |
| 595 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-((R)-1-methoxy-ethyl)-piperazin-2-one | 490, 492 CI pattern |
| 596 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3-(S)-((R)-1-methoxy-ethyl)-piperazin-2-one | 472, 474 CI pattern |
| 597 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-(S)-((R)-1-methoxy-ethyl)-piperazin-2-one | 486, 488 CI pattern |
| 598 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-3-(S)-((R)-1-methoxy-ethyl)-piperazin-2-one | 530, 532 Br pattern |
| 599 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-isoquinolin-3- | 491, 493 |

| | | |
|-----|--|-------------------------|
| | ylmethyl)-3-(S)-((R)-1-methoxy-ethyl)-piperazin-2-one | CI pattern |
| 600 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-3-(S)-isopropyl-piperazin-2-one | 480, 482 CI, pattern |
| 601 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-3,3-dimethyl-piperazin-2-one | 466, 468 CI pattern |
| 602 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,3-dimethyl-piperazin-2-one | 442, 444 CI pattern |
| 603 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3,3-dimethyl-piperazin-2-one | 456, 458 CI pattern |
| 604 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-carbonyl)-3,3-dimethyl-piperazin-2-one | 480, 482 CI pattern |
| 605 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-(2-methoxy-ethyl)-piperazin-2-one | 490, 492 CI pattern |
| 606 | 4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-(2-methoxy-ethyl)-3-oxo-piperazine-1-carboxylic acid (4-chloro-phenyl)-amide | 469, 471 CI pattern |
| 607 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-3-yloxy)-acetyl]-3-(S)-(2-methoxy-ethyl)-piperazin-2-one | 490, 492 CI pattern |
| 608 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-carbonyl)-3-(S)-(2-methoxy-ethyl)-piperazin-2-one | 510, 512 CI pattern |

EXAMPLE 609. 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-naphthalen-2-ylmethyl)-3-(S)-methoxymethyl-6-(S)-methyl-piperazin-2-one.

The title compound is prepared as described in EXAMPLE 268, using 1-(4-amino-quinazoline-7-ylmethyl)-3-methoxymethyl-6-methyl-piperazine-2-one, EXAMPLE 87, and 2-bromomethyl-6-chloronaphthalene, EXAMPLE 12. ¹H NMR (CDCl₃, 300 MHz) δ 8.59 (s, 1H), 7.79 (d, 1H), 7.70-7.12 (m, 3H), 7.68-7.67 (m, 2H), 7.55 (d, 1H), 7.39 (d, 1H), 4.78 (d, 2H), 3.98 (d, 2H), 3.44 (s, 3H), 3.38 (t, 1H), 2.64 (m, 2H), 1.26 (d, 3H). MS (ISP) 490, 492, (M+H), CI pattern.

The following materials are prepared from starting materials obtained as described in Example 87 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|------------------------|
| 610 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-propyl]-3-(S)-ethyl-6-methyl-piperazin-2-one | 458, 460 CI pattern |

| | | |
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| 611 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-naphthalen-2-ylmethyl)-3-(S)-methoxymethyl-6-(R)-methyl-piperazin-2-one | 490, 492 CI pattern |
| 612 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3-(S)-methoxymethyl-6-methyl-piperazin-2-one | 472, 474 CI pattern |
| 613 | (1-(4-Amino-quinazolin-7-ylmethyl)-4-(7-chloro-isoquinolin-3-ylmethyl)-3-(S)-methoxymethyl-6-methyl-piperazin-2-one | 490, 492 CI pattern |
| 614 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3-(S)-6-dimethyl-piperazin-2-one | 491, 493 CI pattern |
| 615 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-naphthalen-2-ylmethyl)-6-methyl-piperazin-2-one | 442, 446 CI pattern |
| 616 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-6-methyl-piperazin-2-one | 428, 430 CI pattern |

EXAMPLE 617. 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3(S)-methoxymethyl-6-methyl-piperazin-2-one.

The title compound is prepared as described in EXAMPLE 123 using 1-(4-amino-quinazolin-7-ylmethyl)-3-methoxymethyl-6-methyl-piperazine-2-one, EXAMPLE 87, and 5-chloro-2-thienyloxyacetic acid, EXAMPLE 24. ¹H NMR (CD₃OD 300 MHz) δ 8.68 (s, 1H), 8.27 (d, 1H), 7.62 (m, 2H), 6.54 (d, 1H), 6.18 (m, 1H), 7.39 (d, 1H), 4.94 (m, 4H), 4.15 (m, 2H), 3.76 (m, 2H), 3.44 (s, 3H), 3.10 (m, 2H), 1.28 (d, 3H).

The following compounds are prepared from compounds obtained as described

10 Examples 75-87 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|---|-------------------------------------|
| 618 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(4-chloro-thiophen-2-yloxy)-acetyl]-3-(S)-3-methoxymethyl-6-methyl-piperazin-2-one | 490, 492 CI pattern |
| 619 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-3-yloxy)-acetyl]-3-(S)-3-methoxymethyl-6-methyl-piperazin-2-one | 490, 492 Cl ₂ pattern |
| 620 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3-chloro-4-fluoro-phenoxy)-acetyl]-3(S)-methoxymethyl-6-methyl-piperazin-2-one | 502, 504 Cl ₂ pattern |
| 621 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3,5-dichloro-phenoxy)-acetyl]-3(S)-methoxymethyl-6-methyl-piperazin-2-one | 502, 504 CI pattern |
| 622 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(2,5-dichloro-phenyl)-acryloyl]-3(S)-methoxymethyl-6-methyl-piperazin-2-one | 514 |
| 623 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-2-methyl-phenoxy)- | 498, 500 |

| | | |
|-----|--|-------------------------|
| | acetyl]-3(S)-methoxymethyl-6-methyl-piperazin-2-one | Cl ₂ pattern |
| 624 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(2,5-dichloro-phenoxy)-acetyl]-3(S)-methoxymethyl-6-methyl-piperazin-2-one | 518 |
| 625 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(3-chloro-phenoxy)-acetyl]-3(S)-methoxymethyl-6-methyl-piperazin-2-one | 484 |
| 626 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-propionyl]-3(S)-ethyl-6-methyl-piperazin-2-one | 472, 474 Cl pattern |
| 627 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3(S)-ethyl-6-methyl-piperazin-2-one | 474 |
| 628 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-3(S)-ethyl-6-methyl-piperazin-2-one | 514, 516 Br pattern |
| 629 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3(S)-ethyl-6-methyl-piperazin-2-one | 470, 472 Cl pattern |
| 630 | (S)-1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-methoxymethyl-6-methyl-piperazin-2-one | 486, 488 Cl pattern |
| 631 | (S)-1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-3-methoxymethyl-6-methyl-piperazin-2-one | 530, 532 Br pattern |
| 632 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-carbonyl)-3(S)-6-dimethyl-piperazin-2-one | 480 Cl pattern |
| 633 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-3(S)-6-dimethyl-piperazin-2-one | 500, 502 Br pattern |
| 634 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3(S)-6-dimethyl-piperazin-2-one | 456, 458 Cl pattern |
| 635 | 1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-6-methyl-piperazin-2-one | 442, 444 Cl pattern |

EXAMPLE 636. 4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (4-chloro-phenyl)-amide.

The title compound is prepared as described in EXAMPLE 436 using 1-(4-amino-quinazolin-7-ylmethyl)-3-methoxymethyl-piperazine-2-one, EXAMPLE 75, and 4-chlorophenyl isocyanate. ¹H NMR (DMSO-d₆, 300 MHz) δ 9.77 (bs, 2H), 8.81 (s, 1H), 8.70 (s, 1H), 8.40 (d, 1H), 7.64 (d, 1H), 7.61 (s, 1H), 7.49 (d, 2H), 7.28 (d, 2H), 4.88 (m, 1H), 4.80 (AB, 2H), 4.19 (m, 1H), 3.96 (m, 1H), 3.74-3.42 (m, 4H), 3.28 (s, 3H). ESI MS, [M+H]⁺=455,457 (Cl pattern). Anal. (C₂₂H₂₃ClN₆O₃·TFA·1.5H₂O) C, H, N.

EXAMPLE 637. 4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methyl-3-oxo-piperazine-1-carboxylic acid (5-chloro-thiophen-2-yl)-amide.

The title compound is prepared as described in EXAMPLE 438 using 1-(4-amino-quinazolin-7-ylmethyl)-3-methyl-piperazine-2-one (EXAMPLE 80) and 5-chloro-thiophene-2-carbonyl azide (EXAMPLE 38). ¹H NMR (DMSO-d₆, 300 MHz) δ 10.01 (s, 1H), 9.73 (bs, 2H), 8.83 (s, 1H), 8.39 (d, 1H), 7.65 (d, 1H), 7.58 (s, 1H), 6.79 (d, 1H), 6.44 (d, 1H), 4.85 (d, 1H), 4.71 (m, 1H), 4.69 (d, 1H), 4.17 (d, 1H), 3.50 (m, 3H), 1.45 (d, 3H). ESI MS, [M+H]⁺=431,433 (Cl pattern). Anal. (C₁₉H₁₉ClN₆O₂S·TFA·1.9H₂O) C, H, N.

EXAMPLE 638. 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (5-chloro-thiophen-2-yl)-amide.

The title compound is prepared as described in EXAMPLE 439 using 1-(4-amino-quinazolin-7-ylmethyl)-3-methoxymethyl-piperazine-2-one (EXAMPLE 75) and 5-chloro-thiophene-2-carbonyl azide (EXAMPLE 38). ¹H NMR (DMSO-d₆, 300 MHz) δ 10.00 (s, 1H), 9.73 (bs, 2H), 8.82 (s, 1H), 8.40 (d, 1H), 7.65 (d, 1H), 7.60 (s, 1H), 6.80 (d, 1H), 6.42 (d, 1H), 4.86 (d, 1H), 4.80 (m, 1H), 4.70 (d, 1H), 4.18 (d, 1H), 3.96 (dd, 1H), 3.60 (m, 4H), 3.30 (s, 3H). ESI MS, [M+H]⁺=461,463 (Cl pattern). Anal. (C₂₀H₂₁ClN₆O₃S·TFA·1.1H₂O) C, H, N.

The following compounds are prepared using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|------------------------|
| 639 | 4-(4-Amino-quinazolin-7-ylmethyl)-2(S)-(2-methoxy-ethyl)-3-oxo-piperazine-1-carboxylic acid (4-chloro-phenyl)-amide | 469 |
| 640 | 4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-butyl-3-oxo-piperazine-1-carboxylic acid (4-chloro-phenyl)-amide | 467, 469 Cl pattern |
| 641 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (5-bromo-thiophen-2-yl)-amide | 505, 507 |
| 642 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (5-chloro-thiophen-3-yl)-amide | 461, 463 |
| 643 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (4-chloro-thiophen-2-yl)-amide | 461 |
| 644 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-(S)-2-propyl-piperazine-1-carboxylic acid (4-chloro-phenyl)-amide | 453, 455 Cl pattern |
| 645 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (3-bromo-phenyl)-amide | 499 |

| | | |
|-----|---|------------------------|
| 646 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-(2S)-propyl-piperazine-1-carboxylic acid (4-chloro-thiophen-2-yl)-amide | 459, 461 |
| 647 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-(S)-2-propyl-piperazine-1-carboxylic acid (5-chloro-2-methoxy-phenyl)-amide | 483, 485 CI pattern |
| 648 | 4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (4-bromo-2-chloro-phenyl)-amide | 533, 535 |
| 649 | 4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (4-trifluoromethoxy-phenyl)-amide | 505 |
| 650 | 4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (4-fluoro-phenyl)-amide | 439 |
| 651 | 4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (2,4-dichloro-phenyl)-amide | 489, 491 |
| 652 | 4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (2,4-difluoro-phenyl)-amide | 457 |
| 653 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (3-chloro-phenyl)-amide | 455 |
| 654 | 4-(4-Amino-quinazolin-7-ylmethyl)-3-oxo-(2S)-propyl-piperazine-1-carboxylic acid (5-chloro-thiophen-2-yl)-amide | 459, 460 CI pattern |
| 655 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-methyl-3-oxo-piperazine-1-carboxylic acid (6-chloro-pyridin-3-yl)-amide | 426, 428 |
| 656 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (4-bromo-phenyl)-amide | 499, 501 |
| 657 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-methyl-3-oxo-piperazine-1-carboxylic acid (4-bromo-phenyl)-amide | 486, 488 |
| 658 | 4-(4-Amino-quinazolin-7-ylmethyl)-2-(S)-methoxymethyl-5-(R,S)-methyl-3-oxo-piperazine-1-carboxylic acid (4-chloro-phenyl)-amide | 469, 471 |
| 659 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-ethyl-3-oxo-piperazine-1-carboxylic acid (4-bromo-phenyl)-amide | 483, 485 |
| 660 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-methyl-3-oxo-piperazine-1-carboxylic acid (4-chloro-phenyl)-amide | 425, 427 |
| 661 | 4-(4-Amino-quinazolin-7-ylmethyl)-(2S)-ethyl-3-oxo-piperazine-1-carboxylic acid (4-chloro-phenyl)-amide | 439, 441 |
| 662 | 4-(4-Amino-quinazolin-7-ylmethyl)-(S)-2-methoxymethyl-3-oxo-piperazine-1-carboxylic acid (5-chloro-4-methoxy-thiophen-2-yl)- | 491, 493 CI pattern |

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EXAMPLE 663. (3S, 5RS)-1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-3,5-dimethyl-piperazin-2-one.

(3S,5RS)-1-(4-Amino-quinazolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one (260 mg, 0.56 mmol), EXAMPLE 88, is dissolved in 5 mL of DMF. Potassium carbonate (193.4 mg, 1.4 mmol) is added followed by the addition of 2-bromomethyl-6-chloro-benzo[b]thiophene (218 mg, 0.84 mmol), EXAMPLE 5. Reaction is left to stir overnight. The crude mixture is purified by reverse phase HPLC (10 -70% ACN/H₂O) to afford the product (27 mg, 6%) as a clear wax with a melting point of 130-131 °C. C₂₄H₂₄ClN₅OS MS m/z: 466, 468.

EXAMPLE 664. (3S, 5S)-1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-piperazin-2-one. and

EXAMPLE 665. (3S,5R)-1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-piperazin-2-one.

(3S,5RS)-1-(4-Amino-quinazolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one (60 mg, 0.13 mmol) is dissolved in 1 mL of DMF. Potassium carbonate (53 mg, 0.39 mmol) is added followed by the addition of 3-bromoallyl-5-chloro-thiophene (75 mg, 0.32 mmol). Reaction is left to stir overnight. The two epimers are separated by reverse phase HPLC (10 -70% ACN) in 43% yield.

The major epimer is assigned as (3S, 5S)-1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5 -dimethyl-piperazin-2-one trifluoroacetic acid salt (30.8 mg) and is isolated as a yellow solid with a melting point of 69-72 °C. C₂₂H₂₄ClN₅OS MS m/z: 442, 444.

The minor epimer is assigned as (3S, 5R)-1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-piperazin-2-one trifluoroacetic acid salt (13.1 mg) with a melting point of 67-70 °C. C₂₂H₂₄ClN₅OS MS m/z: 442, 444. ¹H NMR (CD₃OD) δ: 8.67 (s, 1H); 8.31 (d, 1H, J = 8.56 Hz); 7.83 (s, 1H); 7.74 (d, 2H, J = 8.56 Hz); 7.14 (d, 1H, J = 15.6 Hz); 6.92 (d, 1H, J = 3.74 Hz); 6.10-6.03 (m, 1H); 5.0-4.74 (m, 2H); 4.25-3.63 (m, 6 H); 1.78 (d, 3H, J = 7.03 Hz); 1.50 (d, 3H, J = 6.47 Hz).

EXAMPLE 666. (3S, 5R)-1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-3,5-dimethyl-piperazin-2-one.

(3S,5R)-1-(4-Amino-quinazolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one (43 mg, 0.123 mmol), minor epimer from EXAMPLE 88, Part D, is taken up in methylene chloride to this is added triethylamine (0.034 ml, 0.25 mmol) followed by 2-(5-chloro-thiophen-2-yl)-ethenesulfonyl chloride (40 mg, 0.16 mmol), EXAMPLE 3. The reaction is stirred overnight, and

the crude material is purified by preparative thin layer chromatography (15 % methanol/CH₂Cl₂). The product (1.4 mg, 2.3%) is isolated as a yellow wax. C₂₁H₂₂ClN₅O₃S₂ MS m/z: 492, 494. ¹H NMR (CD₃OD) δ 8.36 (s, 1H); 8.03 (d, 1H, J = 7.5 Hz); 7.61 (s, 1H); 7.49-7.44 (m, 2H); 7.19 (d, 1H, J = 3.83 Hz); 6.98 (d, 1H, J = 3.75 Hz); 6.76 (d, 1H, J = 15.1 Hz); 4.86-4.71 (m, 2H); 4.45-4.39 (m, 1H); 4.13-4.09 (m, 1H); 3.64-3.7 (m, 2H); 1.63 (d, 3H, J = 7.09 Hz); 1.33 (d, 3H, J = 6.80 Hz).

EXAMPLE 667. (3S, 5S)-1-(4-Amino-quinazolin-7-ylmethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-3,5-dimethyl-piperazin-2-one.

The product (7 mg, 9.4 %) is isolated as a yellow solid with a melting point of 218-221 °C. C₂₁H₂₂ClN₅O₃S₂ MS m/z: 492, 494. ¹H NMR (CD₃OD) δ 8.37 (s, 1H); 8.10 (d, 1H, J = 8.57 Hz); 7.61-7.45 (m, 3H); 7.24 (d, 1H, J = 3.94 Hz); 6.98 (d, 1H, J = 3.85 Hz); 6.71 (d, 1H, J = 15.1 Hz); 4.76 (s, 2H); 4.32 (m, 1H); 3.71 (m, 1H); 3.36 (m, 2H); 1.62 (d, 3H, J = 7.06 Hz); 1.20 (d, 3H, J = 6.63 Hz).

EXAMPLE 668. (3S, 5S)-1-(4-Amino-quinazolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-sulfonyl)-3,5-dimethyl-piperazin-2-one.

The desired product (5.4 mg, 8.5 %) is isolated as yellow solid with a melting point of 224-226°C. C₂₃H₂₂ClN₅O₃S₂ MS m/z: 516, 518.

EXAMPLE 669. (3S, 5S)-1-(4-Amino-quinazolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3,5-dimethyl-piperazin-2-one.

To a solution of (3S,5S)-1-(4-amino-quinazolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one (42 mg, 0.147 mmol), major epimer from EXAMPLE 88, Part D, in 2 mL of DMF is added TBTU (52 mg, 0.162 mmol), triethylamine (0.02 mL, 0.162 mmol) and 3-(5-chloro-thiophen-2-yl)-acrylic acid (28 mg, 0.15 mmol), EXAMPLE 25. After stirring for two hours, the reaction mixture is directly purified by reverse phase HPLC (10-70 % ACN/H₂O). The product (35.5 mg, 36%) is isolated as a yellow solid with a melting point of 116-120°C. C₂₂H₂₂ClN₅O₂S: MS m/z: 456, 458. Anal. calcd. for C₂₂H₂₂ClN₅O₂S•C₂H₅F₃O₂: C, 50.57; H, 4.07; N, 12.29. Found: C, 46.48; H, 3.64; N, 11.04.

EXAMPLE 670. (3S, 5R)-4-(4-Amino-quinazolin-7-ylmethyl)-2,6-dimethyl-oxo-piperazine-1-carboxylic acid (4-bromo-phenyl)-amide.

4-Bromo-phenyl isocyanate (20.8 mg, 0.105 mmol) is added to solution of (3S,5R)-1-(4-amino-quinazolin-7-ylmethyl)-3,5-dimethyl-piperazin-2-one (30 mg, 0.105 mmol), minor epimer

from EXAMPLE 88, Part D, in 1 mL of DMF. The reaction is stirred for two hours at room temperature. The product (21.4 mg, 33%) is isolated from reverse phase HPLC (10 -70% ACN/H₂O) as white solid. The melting of the compound is 142-144 °C. C₂₂H₂₃BrN₆O₂ MS m/z: 483, 485. Anal. calcd. for C₂₂H₂₃BrN₆O₂•2C₂HF₃O₂: C, 43.90; H, 3.54; N, 11.81. Found: C, 44.52; H, 3.86; N, 12.44.

EXAMPLE 671. (3S, 5S)-4-(4-Amino-quinazolin-7-ylmethyl)-2,6-dimethyl-oxo-piperazine-1-carboxylic acid (4-bromo-phenyl)-amide.

The desired product (35 mg, 47%) is isolated as a white solid with a melting point of 142-144 °C. C₂₂H₂₃BrN₆O₂ MS m/z: 483, 485. Anal. calcd. for C₂₂H₂₃BrN₆O₂•2C₂HF₃O₂: C, 43.90; H, 3.54; N, 11.81. Found: C, 44.73; H, 3.59; N, 12.38.

EXAMPLE 672. (3S, 5S)-4-(4-Amino-quinazolin-7-ylmethyl)-2,6-dimethyl-oxo-piperazine-1-carboxylic acid (4-chloro-phenyl)-amide.

The product (24.7 mg, 50%) is obtained as a white solid with a melting point of 123-125 °C. C₂₂H₂₃ClN₆O₂ MS m/z: 439, 441. Anal. calcd. for C₂₂H₂₃ClN₆O₂•2C₂HF₃O₂: C, 46.82; H, 3.78; N, 12.60. Found: C, 47.69; H, 4.33; N, 13.32.

EXAMPLE 673. 1-(4-Aminoquinolin-7-ylmethyl)-4-(6-chlorobenzo[b]thiophen-2-sulfonyl)-piperazin-2-one.

A. 1-(4-Chloroquinolin-7-ylmethyl)-4-(6-chlorobenzo[b]thiophen-2-sulfonyl)-piperazin-2-one.

1-(4-chloroquinolin-7-ylmethyl)-3-(S)-methylpiperazin-2-one hydrochloride (0.49 g, 1.4 mmol), EXAMPLE 89, is treated with acetonitrile (20 mL), triethyl amine (1.2 ml, 8.4 mmol) and a solution of 6-chlorobenzo[b]thiophen-2-sulfonyl chloride (0.41 g, 1.54 mmol), EXAMPLE 1, in acetonitrile (10 mL) at 0°C. After 2 h the solution is poured into water and extracted with ethyl acetate. The organic layer is washed with water, dried over sodium sulfate and concentrated to yielded the title compound (0.45 g, 0.95 mmol). MS m/z: 506, [M+1]⁺; ¹H NMR (CD₃OD, 300 MHz) δ 8.8 (d, 1H), 8.15 (d, 1H), 7.9 (d, 2H), 7.85 (s, 1H), 7.4-7.5 (m, 2H), 6.8 (s, 1H), 4.8 (s, 2H), 4.0 (s, 2H), 3.4-3.45 (m, 4H).

B. 1-(4-Azidoquinolin-7-ylmethyl)-4-(6-chlorobenzo[b]thiophen-2-sulfonyl)-piperazin-2-one

1-(4-Chloroquinolin-7-ylmethyl)-4-(6-chlorobenzo[b]thiophen-2-sulfonyl)-piperazin-2-one (0.52 g, 1.03 mmol) is dissolved in DMF (15 mL), treated with sodium azide (0.52 g, 8.0 mmol), tetrabutyl ammonium chloride (0.1 g, 0.36 mmol) and heated to 65 °C overnight. The reaction

mixture is cooled, poured into water and extracted with ethyl acetate. The organic layer is washed with water, dried (sodium sulfate) and concentrated to give the title compound (0.5 g, 1.04 mmol). ¹H NMR (CD₃OD, 300 MHz) δ 9.0 (d, 1H), 8.2 (d, 1H), 8.0 (s, 1H), 7.9 (d, 2H), 7.8 (d, 1H), 7.6 (d, 1H), 7.5 (d, 1H), 6.9 (s, 1H), 4.85 (s, 2H), 4.0 (s, 2H), 3.5-3.7 (m, 4H).

5

C. 1-(4-Aminoquinolin-7-ylmethyl)-4-(6-chlorobenzo[b]thiophen-2-sulfonyl)-piperazin-2-one.

A suspension of 1-(4-azidoquinolin-7-ylmethyl)-4-(6-chlorobenzo[b]thiophen-2-sulfonyl)-piperazin-2-one (0.50 g, 1.04 mmol) in 100 mL of acetic acid/methanol (~ 1:10) is treated with 10% Pd/C (0.15 g) and stirred under hydrogen for 1.5 hours. The resulting solution is filtered
10 through Celite and the filtrate is evaporated in vacuo. The organic layer is concentrated and the residue is purified by reverse phase HPLC (gradient elution of 30 % of 0.1 % aqueous TFA/acetonitrile to 100 % acetonitrile) and lyophilized to give the title compound (0.39 g, 0.86 mmol). MS (ISP) m/z 487, 489, (M+H), CI pattern.

15 The following compounds are prepared from the compound of Example 89 or 91 using the methods described above.

| Exempl e | Name | m/z [M+H] |
|-------------|--|-----------|
| 674 | 1-(4-Amino-quinolin-7-ylmethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethene-sulfonyl]-piperazin-2-one | 463, 465 |
| 675 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-3-methyl-piperazin-2-one | 501, 503 |
| 676 | (3S,5S)-1-(4-Amino-quinolin-7-ylmethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-3,5-dimethyl-piperazin-2-one | 491, 493 |
| 677 | (3S,5R)-1-(4-Amino-quinolin-7-ylmethyl)-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-3,5-dimethyl-piperazin-2-one | 491, 493 |
| 678 | (S,R)-1-(4-Amino-quinolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-carboxylic acid | 531, 533 |
| 679 | 1-(4-Amino-quinolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-carboxylic acid methylamide | 544 |
| 680 | 1-(4-Amino-quinolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-carboxylic acid ethylamide | 558 |
| 681 | 1-(4-Amino-quinolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-oxo-piperazine-2-carboxylic acid dimethylamide | 558 |

| | | |
|-----|---|-----|
| 682 | 1-(4-Amino-quinolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-6-(morpholine-4-carbonyl)-piperazin-2-one | 600 |
|-----|---|-----|

EXAMPLE 683. (S)-1-(4-Aminoquinolin-7-ylmethyl)-4-[3-(5-chlorothiophen-2-yl)-allyl]-3-methylpiperazin-2-one.

A. (S)-1-(4-Chloroquinolin-7-ylmethyl)-4-[3-(5-chlorothiophen-2-yl)-allyl]-3-methylpiperazin-2-one.

(S)-1-(4-chloroquinolin-7-ylmethyl)-3-methylpiperazin-2-one hydrochloride (0.25 g, 1.0 mmol), EXAMPLE 91, is treated with 2-(3-Bromo-(E)-propenyl)-5-chloro-thiophene (0.35 g 1.2 mmol), EXAMPLE 17, and potassium carbonate (0.5 g, 3 mmol). The resulting suspension is sonicated for 10 minutes then stirred vigorously for 16 h at ambient temperature. The reaction mixture is poured into water and extracted with ethyl acetate (2 X 150 mL). The organic layer is washed with water (4 X 200 mL), dried over sodium sulfate and concentrated. The residue is chromatographed (3 % methanol/methylene chloride) to give the title compound (0.31 g, 0.73 mmol).

B. (S)-1-(4-Aminoquinolin-7-ylmethyl)-4-[3-(5-chlorothiophen-2-yl)-allyl]-3-methylpiperazin-2-one.

(S)-1-(4-Chloroquinolin-7-ylmethyl)-4-[3-(5-chlorothiophen-2-yl)-allyl]-3-methylpiperazin-2-one (0.35 g, 0.82 mmol) is treated with phenol (2 g) and ammonium acetate (0.7 g, 9.1 mmol) and heated to 120 °C in a sealed vessel for 1 hour. Upon cooling, the solution is partitioned between 2 N NaOH and ethyl acetate. The organic layer is separated and washed with fresh 2 N NaOH (3 X 100 mL) and water. The organic layer is concentrated and the residue is purified by reverse phase HPLC to give the title compound as a white solid (0.15 g, 0.35 mmol). MS (ISP) m/z 427, 429, (M+H), Cl pattern.

The following compounds are prepared from starting materials prepared as described in Examples 61-64, 89 or 91 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|-----------|
| 684 | 1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-piperazin-2-one | 413, 415 |
| 685 | (3S, 5R)-1-(4-Amino-quinolin-7-ylmethyl)-4-(6-chloro-benzo[b]thiophen-2-ylmethyl)-3,5-dimethyl-piperazin-2-one | 465, 467 |
| 686 | (3S, 5S)-1-(4-Amino-quinolin-7-ylmethyl)-4-(6-chloro- | 464 |

| | | |
|-----|--|----------|
| | benzo[b]thiophen-2-ylmethyl)-3,5-dimethyl-piperazin-2-one | |
| 687 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-(7-chloro-isoquinolin-3-ylmethyl)-3-methyl-piperazin-2-one | 446,448 |
| 688 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-(6-chloro-naphthalen-2-ylmethyl)-3-methyl-piperazin-2-one | 444 |
| 689 | (3S,5S)-1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-piperazin-2-one | 441, 443 |
| 690 | (3S,5R)-1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3,5-dimethyl-piperazin-2-one | 441, 443 |
| 691 | 1-(4-Amino-quinolin-7-ylmethyl)-4-(5-chloro-1H-indol-2-ylmethyl)-piperazin-2-one | 420, 422 |
| 692 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-(6-chloro-naphthalen-2-ylmethyl)-3-ethyl-piperazin-2-one | 458 |
| 693 | 1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-(S)-3-((R)-1-methoxy-ethyl)-piperazin-2-one | 470 |
| 694 | 1-(4-Amino-quinolin-7-ylmethyl)-4-(7-chloro-isoquinolin-3-ylmethyl)-(S)-3-((R)-1-methoxy-ethyl)-piperazin-2-one | 489 |
| 695 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-(5-chloro-1H-indol-2-ylmethyl)-3-methoxymethyl-piperazin-2-one | 464, 466 |
| 696 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-(5-chloro-1H-indol-2-ylmethyl)-3-methyl-piperazin-2-one | 434, 436 |
| 697 | 4-(5-Chloro-1H-indol-2-ylmethyl)-1-[4-(2-hydroxy-ethylamino)-quinolin-7-ylmethyl]-piperazin-2-one | 464 |
| 698 | (S)-4-(5-Chloro-1H-indol-2-ylmethyl)-1-(4-ethylamino-quinolin-7-ylmethyl)-3-methyl-piperazin-2-one | 462 |
| 699 | (S)-4-(5-Chloro-1H-indol-2-ylmethyl)-1-(4-ethylamino-quinolin-7-ylmethyl)-3-methoxymethyl-piperazin-2-one | 492 |
| 700 | (S)-4-(5-Chloro-1H-indol-2-ylmethyl)-3-methyl-1-(4-methylamino-quinolin-7-ylmethyl)-piperazin-2-one | 448 |
| 701 | (S)-4-(5-Chloro-1H-indol-2-ylmethyl)-3-methoxymethyl-1-(4-methylamino-quinolin-7-ylmethyl)-piperazin-2-one | 478 |
| 702 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-allyl]-3-methyl-4-oxy-piperazin-2-one | 443 |

EXAMPLE 703. (S)-1-(4-Aminoquinolin-7-ylmethyl)-4-[3-(4-bromothiophen-2-yl)acryloyl]-3-methyl-piperazin-2-one.

A. (S)-1-(4-Chloroquinolin-7-ylmethyl)-4-[3-(4-bromothiophen-2-yl)acryloyl]-3-methyl piperazin-2-one.

(S)-1-(4-chloroquinolin-7-ylmethyl)-3-methylpiperazin-2-one hydrochloride (0.35 g, 1.4 mmol), EXAMPLE 91, is treated with DMF (20 mL), 3-(4-bromothiophen-2-yl)-(E)-acrylic acid (0.32 g, 1.4 mmol), prepared according to EXAMPLE 26, using 4-bromothiophene-2-carboxaldehyde, triethyl amine (0.21 ml, 1.4 mmol) and 2-(1H-benzotriazol-1-yl)1,1,3,3-tetramethyluronium tetrafluoroborate (0.45 g, 1.4 mmol) and heated to 50 °C for 5 minutes. The reaction mixture is stirred at ambient temperature for 16 h then partitioned between ethyl acetate and water. The organic layer is concentrated and the residue is chromatographed (5% methanol/methylene chloride) to give crude title compound (0.5 g, 0.9 mmol). MS m/z: [M+H]⁺ = 504. ¹H NMR (CDCl₃, 300 MHz) δ 8.9 (d, 1H), 8.2-8.3(m, 2H), 8.0 (s, 1H), 7.7-7.8 (m, 1H), 7.4 (s, 1H), 7.3-7.4 (m, 1H), 6.7-6.8 (m, 1H), 6.6 (d, 1H), 5.1-5.2 (m, 1H), 4.6-4.7 (m, 2H), 3.4-3.6 (m, 2H), 3.0-3.3 (m, 2H), 1.5 (d, 3H).

B. (S)-1-(4-Aminoquinolin-7-ylmethyl)-4-[3-(4-bromothiophen-2-yl)acryloyl]-3-methyl-piperazin-2-one.

(S)-1-(4-Chloroquinolin-7-ylmethyl)-4-[3-(4-bromothiophen-2-yl)acryloyl]-3-methyl piperazin-2-one (0.50 g, 0.9 mmol) is treated with phenol (~ 2 g) and ammonium acetate (0.5 g, 6.4 mmol) and heated to 120 °C in a sealed vessel for 1 hour. Upon cooling, the solution is partitioned between 2 N NaOH and ethyl acetate. The organic layer is separated and washed with fresh 2 N NaOH (3 X 100 mL) and water. The organic layer is concentrated and the residue is purified by reverse phase HPLC (gradient elution of 10 % of 0.1 % aqueous TFA/acetonitrile to 100 % acetonitrile) to give the title compound (0.22 g, 0.56 mmol). MS m/z: [M+H]⁺ = 485, 487, Cl pattern. ¹H NMR (CD₃OD, 300 MHz) δ 8.2-8.4 (m, 2H), 7.7-7.8 (m, 2H), 7.6 (d, 1H), 7.5 (s, 1H), 7.3 (s, 1H), 6.9-7.0 (m, 1H), 6.7 (d, 1H), 5.0-5.1 (m, 1H), 4.9 (q, 2H), 4.3-4.4 (m, 1H), 3.5-3.7 (m, 2H), 3.3-3.4 (m, 2H), 1.5 (d, 3H).

The following compounds are prepared from starting materials prepared as described in Examples 75-87 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|------|-----------|
|---------|------|-----------|

| | | |
|-----|--|-------------------|
| 704 | 1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3(S)-ethyl-6-methyl-piperazin-2-one | 469 CI pattern |
| 705 | 4-[3-(5-Chloro-thiophen-2-yl)-acryloyl]-(S)-3-ethyl-1-(4-hydroxyamino-quinolin-7-ylmethyl)-piperazin-2-one | 471, 473 |
| 706 | 1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-piperazin-2-one | 427, 429 |
| 707 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-ethyl-piperazin-2-one | 454 |
| 708 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-methyl-piperazin-2-one | 441, 443 |
| 709 | 1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-piperazin-2-one | 471, 473 |
| 710 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-methoxymethyl-piperazin-2-one | 470 |
| 711 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(4-bromo-thiophen-2-yl)-acryloyl]-3-ethyl-piperazin-2-one | 498 |
| 712 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-ethyl-piperazin-2-one | 458 |
| 713 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-[(5-chloro-thiophen-2-yloxy)-acetyl]-3-methoxymethyl-6-methyl-piperazin-2-one | 488 |
| 714 | 1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-(S)-3-(1-(R)-methoxy-ethyl)-piperazin-2-one | 484 |
| 715 | 1-(4-Aminoquinolin-7-ylmethyl)-4-[3-(4-bromothiophen-2-yl)-acryloyl]-3-(S)-(1-(R)-methoxyethyl)-piperazin-2-one trifluoroacetate | 528 |
| 716 | 1-(4-Aminoquinolin-7-ylmethyl)-4-[(5-chlorothiophen-2-yloxy-acetyl]-3-(S)-(1-(R)-methoxyethyl)-piperazin-2-one trifluoroacetate | 488 |
| 717 | (S)-1-(4-Amino-quinolin-7-ylmethyl)-4-[3-(5-chloro-thiophen-2-yl)-acryloyl]-3-ethyl-piperazin-2-one | 454 |

EXAMPLE 718. 1-(4-Aminocinnolin-7-ylmethyl)-4-[2-(5-chlorothiophen-2-yl)-ethenesulfonyl]-piperazin-2-one.

A. 1-(4-Chlorocinnolin-7-ylmethyl)-4-[2-(5-chlorothiophen-2-yl)-ethenesulfonyl]-piperazin-2-one

5 1-(4-chlorocinnolin-7-ylmethyl)-piperazin-2-one hydrochloride (0.14 g, 0.4 mmol), EXAMPLE 90, is treated with acetonitrile (20 mL), triethylamine (2 mL, 14 mmol) and 2-(5-chlorothiophen-2-yl)ethene-sulfonyl chloride (0.097 g, 0.4 mmol), EXAMPLE 3, at 0°C. The

solution is warmed to ambient temperature over 1.5 h and diluted with ethyl acetate. The solution is washed with 10 % sodium bicarbonate solution and water, dried (sodium sulfate) and concentrated to yield the title compound (0.17 g, 0.35 mmol). MS m/z: $[M+H]^+ = 483$; 1H NMR ($CDCl_3$, 300 MHz) δ 9.4 (s, 1H), 8.4 (s, 1H), 8.3 (d, 1H), 7.85 (d, 1H), 7.7 (d, 1H), 7.1 (d, 1H), 6.95 (d, 1H), 6.35 (d, 1H), 4.9 (s, 2H), 4.0 (s, 2H), 3.4-3.5 (m, 4H).

B. 1-(4-Aminocinnolin-7-ylmethyl)-4-[2-(5-chlorothiophen-2-yl)-ethenesulfonyl]-piperazin-2-one
1-(4-Chlorocinnolin-7-ylmethyl)-4-[2-(5-chlorothiophen-2-yl)-ethenesulfonyl]-piperazin-2-one (0.06 g, 0.12 mmol) is treated with phenol (0.20 g) and ammonium acetate (0.2 g, 2.6 mmol) and heated to 120 °C for 45 minutes. The reaction mixture is cooled, diluted with ethyl acetate and washed with 1 N NaOH (3 X 100 mL) and water. The organic layer is concentrated and the residue is purified by reverse phase HPLC (20 % aqueous TFA (0.1 %)/acetonitrile to 100 % acetonitrile). Fractions containing the desired product are lyophilized to obtain the title compound (0.02 g, 0.043 mmol). MS m/z: $[M+H]^+ = 464$; 1H NMR (CD_3OD , 300 MHz) δ 8.6 (s, 1H), 8.4 (d, 1H), 7.75 (d, 1H), 7.65 (d, 1H), 7.35 (d, 1H), 7.1 (d, 1H), 6.8 (d, 1H), 4.9 (s, 2H), 4.05 (s, 2H), 3.6 (m, 4H).

EXAMPLE 719. 4-(6-Chloro-thieno[2,3-b]pyridine-2-sulfonyl)-1-[2-(pyridin-4-ylamino)-ethyl]-piperazin-2-one.
1-[2-(Pyridin-4-ylamino)-ethyl]-piperazin-2-one (0.20 mmol), EXAMPLE 90, is dissolved in MeCN (5 mL) and treated with 4-methylmorpholine (0.055 ml, 0.50 mmol). 6-Chloro-thieno[2,3-b]pyridine-2-sulfonyl chloride (54 mg, 0.20 mmol) in MeCN (2 mL) is added dropwise. The reaction mixture is stirred at r.t. for 1.5 h, then subjected to HPLC purification, to give the title compound as white solid (0.021 g, 0.037 mmol). MS m/z 452, 454 (M+1); 1H NMR (CD_3OD , 300 MHz) δ 8.37 (d, 1H), 8.30 (b, 1H), 8.12 (d, 1H), 8.02 (s, 1H), 7.97 (d, 1H), 7.57 (d, 1H), 6.98 (d, 1H), 6.88 (d, 2H), 3.73 (s, 2H), 3.60-3.48 (m, 8H).

EXAMPLE 720. 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-[2-(methyl-pyridin-4-yl-amino)-ethyl]-piperazin-2-one.
A portion (~50%) of the crude 1-[2-((Methyl)-(pyridin-4-yl)-amino)-ethyl]-piperazin-2-one, EXAMPLE 93 is reacted with 6-chloro-benzo[b]thiophene-2-sulfonyl chloride (54 mg, 0.20 mmol), EXAMPLE 1, using same procedure as described in EXAMPLE 719. The residue obtained after HPLC purification is subjected to silica gel chromatography using $NH_4OH/MeOH/CH_2Cl_2$ (1:4:95) as eluant to give title compound (30 mg, 0.064 mmol) as a white solid. MS m/z 465, 457 (M+1); 1H NMR ($CDCl_3$, 300 MHz) δ 8.15 (d, 2H), 7.88 (s, 1H), 7.85 (d,

1H), 7.79 (s, 1H), 7.47 (d, 1H), 6.47 (d, 2H), 3.80 (s, 2H), 3.50 (m, 4H), 3.43 (d, 2H), 3.30 (d, 2H), 2.98 (s, 3H).

EXAMPLE 721. 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-1-[2-(3-methyl-pyridin-4-ylamino)-ethyl]-piperazin-2-one.

1-[2-(3-Methylpyridin-4-yl-amino)-ethyl]-piperazin-2-one (38 mg, 0.16 mmol), EXAMPLE 94, is reacted with 2-(5-chloro-thiophen-2-yl)-ethenesulfonyl chloride (40 mg, 0.16 mmol), EXAMPLE 3, using the same procedure as described in EXAMPLE 719. Reverse phase HPLC purification gives the title compound (29 mg, 0.052 mmol) as a white solid. MS m/z 441, 443 (M+H); ¹H NMR (CD₃OD, 300 MHz) δ 8.08 (d, 1H), 7.98 (s, 1H), 7.56 (d, 1H), 7.30 (d, 1H), 7.02 (s, 1H), 7.00 (d, 1H), 6.78 (d, 1H), 3.87 (s, 2H), 3.70-3.50 (m, 8H), 2.15 (s, 3H).

The following compounds are prepared from starting materials obtained as described in Examples 92-97 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|--|-----------|
| 722 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-[2-(pyridin-4-ylamino)-ethyl]-piperazin-2-one | 520 (M+) |
| 723 | 1-[2-(Pyridin-4-ylamino)-ethyl]-4-(thieno[2,3-b]pyridine-2-sulfonyl)-piperazin-2-one | 417 |
| 724 | 4-(5'-Chloro-[2,2']bithiophenyl-5-sulfonyl)-1-[2-(pyridin-4-ylamino)-ethyl]-piperazin-2-one | 483, 485 |
| 725 | 1-[2-(Pyridin-4-ylamino)-ethyl]-4-(thieno[3,2-b]pyridine-2-sulfonyl)-piperazin-2-one | 418 |
| 726 | 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-1-[2-(pyridin-4-ylamino)-ethyl]-piperazin-2-one | 427, 429 |
| 727 | 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-1-[2-(methylpyridin-4-ylamino)-ethyl]-piperazin-2-one | 441 |
| 728 | 4-(2-Benzo[b]thiophen-2-yl-ethenesulfonyl)-1-[2-(pyridin-4-ylamino)-ethyl]-piperazin-2-one | 443 |
| 729 | 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-[2-(3-methyl-pyridin-4-ylamino)-ethyl]-piperazin-2-one | 465, 467 |
| 730 | 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-1-(2-pyrrolo[3,2-c]pyridin-1-yl-ethyl)-piperazin-2-one | 450, 452 |

| | | |
|-----|---|-----------------------|
| 731 | 1-[2-(2-Amino-3-chloro-pyridin-4-ylamino)-ethyl]-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-piperazin-2-one | 476, 478 |
| 732 | 1-[2-(2-Amino-5-chloro-pyridin-4-ylamino)-ethyl]-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-piperazin-2-one | 476, 478 |
| 733 | 4-[2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl]-1-[2-(2,3,5,6-tetrachloro-pyridin-4-ylamino)-ethyl]-piperazin-2-one | 563, 565, 567, 569 |
| 734 | 1-[2-(2-Amino-3,5,6-trichloro-pyridin-4-ylamino)-ethyl]-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-piperazin-2-one | 544, 546, 548 |
| 735 | 4-[3-(5-Chloro-thiophen-2-yl)-acryloyl]-1-[2-(pyridin-4-ylamino)-ethyl]-piperazin-2-one | 391, 393 |

EXAMPLE 736. 4-(6-Chloro-benzo[b]thiophene-2-sulfonyl)-1-[2-(pyridazin-4-yl-amino)-ethyl]-piperazin-2-one.

1-[2-(Pyridazin-4-ylamino)-ethyl]-piperazin-2-one hydrochloride (0.5 g, 1.7 mmol),

EXAMPLE 95, is reacted with 6-chloro-benzo[b]thiophene-2-sulfonyl chloride (0.40 g, 1.5

5 mmol), EXAMPLE 1, using essentially the same procedure as described in EXAMPLE 719.

Reverse phase HPLC purification gives the title compound (0.34 g, 0.75 mmol) as a white solid.

MS m/z (M+H= 452); ¹H NMR (CD₃OD, 300 MHz) δ 8.6 (d, 1H), 8.4 (d, 1H), 8.05 (s, 1H), 8.05 (s, 1H), 7.9 (d, 1H), 7.5 (d, 1H), 7.2 (d, 1H), 3.8 (s, 2H), 3.4-3.7 (m, 8H).

10 EXAMPLE 737. 1-[3-(4-Amino-pyridin-3-yl)-propenyl]-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-piperazin-2-one.

4-[3-(4-tert-Butoxycarbonylamino-pyridin-3-yl)-propenyl]-3-oxo-piperazine-1-carboxylic acid tert-butyl ester from EXAMPLE 96, Part B (45 mg, 0.10 mmol) is dissolved in 20% TFA/

CH₂Cl₂ and stirred at r.t. for 2 hours. The solution is concentrated to residue. The residue is

15 dissolved in MeCN (2.5 ml) and treated with 4-methylmorpholine (0.027 ml, 0.25 mmol). 2-(5-Chloro-thiophen-2-yl)-ethenesulfonyl chloride (24 mg, 0.10 mmol), EXAMPLE 3, in MeCN (1

mL) is then added dropwise. The reaction mixture is stirred at r.t. for 1 h, then subjected to reverse phase HPLC purification, to give the title compound as white solid (0.040 g, 0.037

mmol). MS m/z 439, 441 (M+H); ¹H NMR (CD₃OD, 300 MHz) δ 8.20 (br, 1H), 8.10 (s, 1H), 8.08

20 (d, 1H), 7.60 (d, 1H), 7.53 (d, 1H), 7.35 (d, 1H), 7.21 (d, 1H), 7.07 (d, 1H), 6.82 (d, 1H), 5.27 (m, 1H), 3.88 (s, 2H), 3.60-3.50 (m, 4H), 3.30 (d, 2H).

The following compounds are prepared from starting materials obtained as described in Examples 92-97 using the methods described above.

| Example | Name | m/z [M+H] |
|---------|---|-----------|
| 738 | 1-[3-(4-Amino-pyridin-3-yl)-propenyl]-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 463, 465 |
| 739 | 1-[3-(4-Amino-pyridin-3-yl)-allyl]-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 463, 465 |
| 740 | 1-[3-(4-Amino-pyridin-3-yl)-allyl]-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-piperazin-2-one | 439, 441 |
| 741 | 1-[3-(4-Amino-pyridin-3-yl)-propyl]-4-(6-chloro-benzo[b]thiophene-2-sulfonyl)-piperazin-2-one | 465, 467 |
| 742 | 1-[3-(4-Amino-pyridin-3-yl)-propyl]-4-[2-(5-chloro-thiophen-2-yl)-ethenesulfonyl]-piperazin-2-one | 441, 443 |

5 EXAMPLE 743. 4-[2-(5-Chlorothiophen-2-yl)-ethenesulfonyl]-1-(2-pyrrolo[3,2-c]pyridin-1-ylethyl)-piperazin-2-one.

4-(Benzyloxycarbonyl)-1-(2-pyrrolo[3,2-c]pyridin-1-ylethyl)-piperazin-2-one (0.028 g, 0.074 mmol), EXAMPLE 98, is treated with 4 % HCO₂H/MeOH (5 mL) and a catalytic amount of Pd black for 5 minutes. The reaction mixture is filtered washed with methanol and the filtrate is
 10 concentrated to a residue. The residue is treated with acetonitrile (3 mL) excess N-methylmorpholine (0.04 mL) and 2-(5-chlorothiophen-2-yl)ethene-sulfonyl chloride (0.018 g, 0.074 mmol), EXAMPLE 3, and processed as usual (EXAMPLE 719). Further chromatographic purification (NH₄OH/MeOH/CH₂Cl₂:1/4/95) yields the title compound: MS m/z 451, 453 (M+H);
 15 ¹H NMR (CDCl₃, 300 MHz) δ 8.93 (bs, 1H), 8.24 (bs, 1H), 7.41 (d, 1H), 7.23 (d, 1H), 7.14 (m, 2H), 6.94 (d, 1H), 6.68 (d, 1H), 6.18 (d, 1H), 4.43 (t, 2H), 3.67 (t, 2H), 2.88 (t, 2H), 2.66 (t, 2H).

EXAMPLE 744. 4-Prop-2-ynyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

20 A. 2-(2-Oxo-4-prop-2-ynyl-piperazin-1-ylmethyl)-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester.

A solution containing 2-(2-oxo-piperazin-1-ylmethyl)-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (4.3 g, 13.0 mmol), EXAMPLE 69, in CH₃CN (250 mL) is cooled to 0°C. Potassium carbonate (1.98 g, 14.3 mmol) is added to the reaction mixture followed by propargyl bromide (1.55g, 13.0 mmol). The mixture is slowly warmed to ambient temperature and

maintained until complete consumption of starting material is observed by TLC (approx. 8 h). The mixture is concentrated to dryness and then partitioned between aqueous NaHCO₃ (200 mL) and CH₂Cl₂ (200 mL) and the layers are separated. The aqueous phase is extracted twice with CH₂Cl₂ (100 mL) and the combined organic phase is washed with brine, dried over anhydrous Na₂SO₄, filtered and concentrated. The crude residue is purified by flash silica gel chromatography (CH₂Cl₂ to 5% MeOH/CH₂Cl₂) to provide 3.38 g (70%) of the title compound as a pale yellow solid. ¹H NMR (300 MHz, CDCl₃) δ 1.69 (s, 9H), 2.34 (t, J = 2.4 Hz, 1H), 2.89 (m, 2H), 3.42 (s, 2H), 3.45 (d, J = 2.4 Hz, 2H), 3.52 (m, 2H), 4.95 (d, J = 1.4 Hz, 2H), 6.42 (br s, 1H), 7.88 (dd, J = 5.8, 0.8 Hz, 1H), 8.41 (d, J = 5.8 Hz, 1H), 8.78 (d, J = 0.8 Hz, 1H) ppm; MS (EI): m/z 368 (M⁺).

B. 4-Prop-2-ynyl-1-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

To a solution containing 2-(2-oxo-4-prop-2-ynyl-piperazin-1-ylmethyl)-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (1.3 g, 3.53 mmol) in CH₂Cl₂ (100 mL) is added TFA (20 mL) at 0 °C. After 6 h, the reaction mixture is concentrated to dryness and then partitioned between aqueous NaHCO₃ (500 mL) and CH₂Cl₂ (200 mL) and the layers are separated. The aqueous phase is extracted four times with CH₂Cl₂ (100 mL) and the combined organic phase is washed with brine, dried over anhydrous Na₂SO₄, filtered and concentrated. The crude residue is purified by flash silica gel chromatography (CH₂Cl₂ to 10% MeOH/CH₂Cl₂) to provide 616 mg (65%) of the title compound as a pale yellow solid.

¹H NMR (300 MHz, CDCl₃) δ 2.27 (app t, J = 2.4 Hz, 1H), 2.76 (m, 2H), 3.33 (s, 2H), 3.83 (d, J = 2.4 Hz, 2H), 3.45 (m, 2H), 4.57 (s, 2H), 6.47 (s, 1H), 7.23 (d, J = 5.7 Hz, 1H), 8.28 (d, J = 5.7 Hz, 1H), 8.85 (d, J = 0.9 Hz, 1H), 9.34 (br s, 1H) ppm; MS (EI): m/z 268 (M⁺).

EXAMPLE 745. 1,4-Bis-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

A. 2-{4-[3-(4-tert-Butoxycarbonylamino-pyridin-3-yl)-prop-2-ynyl]-2-oxo-piperazin-1-ylmethyl}-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester.

A solution containing 2-(2-oxo-4-prop-2-ynyl-piperazin-1-ylmethyl)-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (100 mg, 0.27 mmol), EXAMPLE 743, (3-iodo-pyridin-4-yl)-carbamic acid tert-butyl ester (87 mg, 0.27 mmol), EXAMPLE 69, Part B, Et₃N (110 mg, 1.08 mmol), (Ph₃P)₄PdCl₂ (10 mg, 0.013 mmol), and CuI (1 mg, 0.008 mmol) in anhydrous DMF (5 mL) is stirred at ambient temperature. After 5 h, the reaction mixture is diluted with EtOAc (50 mL) and water (50 mL) and the layers are separated. The aqueous layer is extracted twice with EtOAc (25 mL) and the combined organic phase is washed with brine,

dried over anhydrous Na_2SO_4 , filtered and concentrated. The crude residue is purified by flash silica gel chromatography (CH_2Cl_2 to 10% MeOH CH_2Cl_2) to provide 77 mg (51%) of the title compound as a colorless oil. ^1H NMR (300 MHz, CDCl_3 , ~2:1 mixture of rotamers) major rotamer: δ 1.53 (s, 9H), 1.69 (s, 9H), 2.98 (m, 2H), 3.49 (s, 2H), 3.56 (m, 2H), 3.78 (s, 2H), 4.98 (s, 2H), 6.43 (s, 1H), 7.89 (m, 1H), 8.09 (m, 2H), 8.34 (m, 1H), 8.41 (m, 1H), 8.75 (m, 1H) ppm; MS (ISP loop): m/z 561 (M+H).

B. 2-[4-(1-tert-Butoxycarbonyl-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-2-oxo-piperazin-1-ylmethyl]-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester.

1,8-Diazabicyclo[5.4.0]undec-7-ene (42 mg, 0.27 mmol) is added to a suspension containing 2-[4-[3-(4-tert-butoxycarbonylamino-pyridin-3-yl)-prop-2-ynyl]-2-oxo-piperazin-1-ylmethyl]-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (77 mg, 0.14 mmol) in anhydrous CH_3CN (10 mL) and the mixture is warmed to 50 °C. After 4 h, the reaction mixture is concentrated to dryness and the residue is partitioned between CH_2Cl_2 (50 mL) and water (50 mL) and the layers are separated. The aqueous layer is extracted twice with CH_2Cl_2 (25 mL) and the combined organic phase is washed with brine, dried over anhydrous Na_2SO_4 , filtered and concentrated to provide 85 mg of the title compound as a crude solid which is used directly without further purification. ^1H NMR (300 MHz, CDCl_3) δ 1.68 (s, 9H), 1.70 (s, 9H), 2.91 (m, 2H), 3.41 (s, 2H), 3.49 (m, 2H), 4.26 (s, 2H), 4.95 (d, J = 1.1 Hz, 2H), 6.39 (d, J = 0.7 Hz, 1H), 6.68 (d, J = 0.7 Hz, 1H), 7.86 (m, 1H), 8.41 (m, 1H), 8.76 (br s, 1H), 8.82 (br s, 1H) ppm; MS (EI): m/z 561 (M+H).

C. 1,4-Bis-(1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-piperazin-2-one.

To a solution containing 2-[4-(1-tert-Butoxycarbonyl-1H-pyrrolo[3,2-c]pyridin-2-ylmethyl)-2-oxo-piperazin-1-ylmethyl]-pyrrolo[3,2-c]pyridine-1-carboxylic acid tert-butyl ester (85 mg, 0.14 mmol) in CH_2Cl_2 (5 mL) is added TFA (1 mL) at 0 °C and the solution is allowed to slowly warm to ambient temperature. After 16 h, the reaction mixture is concentrated to dryness, diluted with water and purified by reverse-phase HPLC [Buffer A: water w/ 0.1% TFA; Buffer B: CH_3CN w/ 0.1% TFA; Gradient: 0% B to 45% B over 30 min] to provide 35 mg (36%, two steps) of the title compound as a pale yellow, lyophilized solid.

^1H NMR (300 MHz, d_6 -DMSO) δ 2.80 (m, 2H), 3.25 (s, 2H), 3.37 (m, 2H), 3.93 (s, 2H), 4.76 (s, 2H), 6.88 (s, 1H), 6.94 (s, 1H), 7.85 (d, J = 6.6 Hz, 1H), 7.89 (d, J = 6.6 Hz, 1H), 8.37 (d, J = 6.7 Hz, 1H), 8.38 (d, J = 6.7 Hz, 1H), 9.17 (s, 1H), 9.19 (s, 1H), 12.80 (s, 1H), 12.96 (s, 1H), 14.91 (br s, 2H) ppm; MS (ion spray): m/z 361 (M+H). $\text{C}_{23}\text{H}_{25}\text{ClN}_4\text{OS}$ MS m/z : 441, 443.